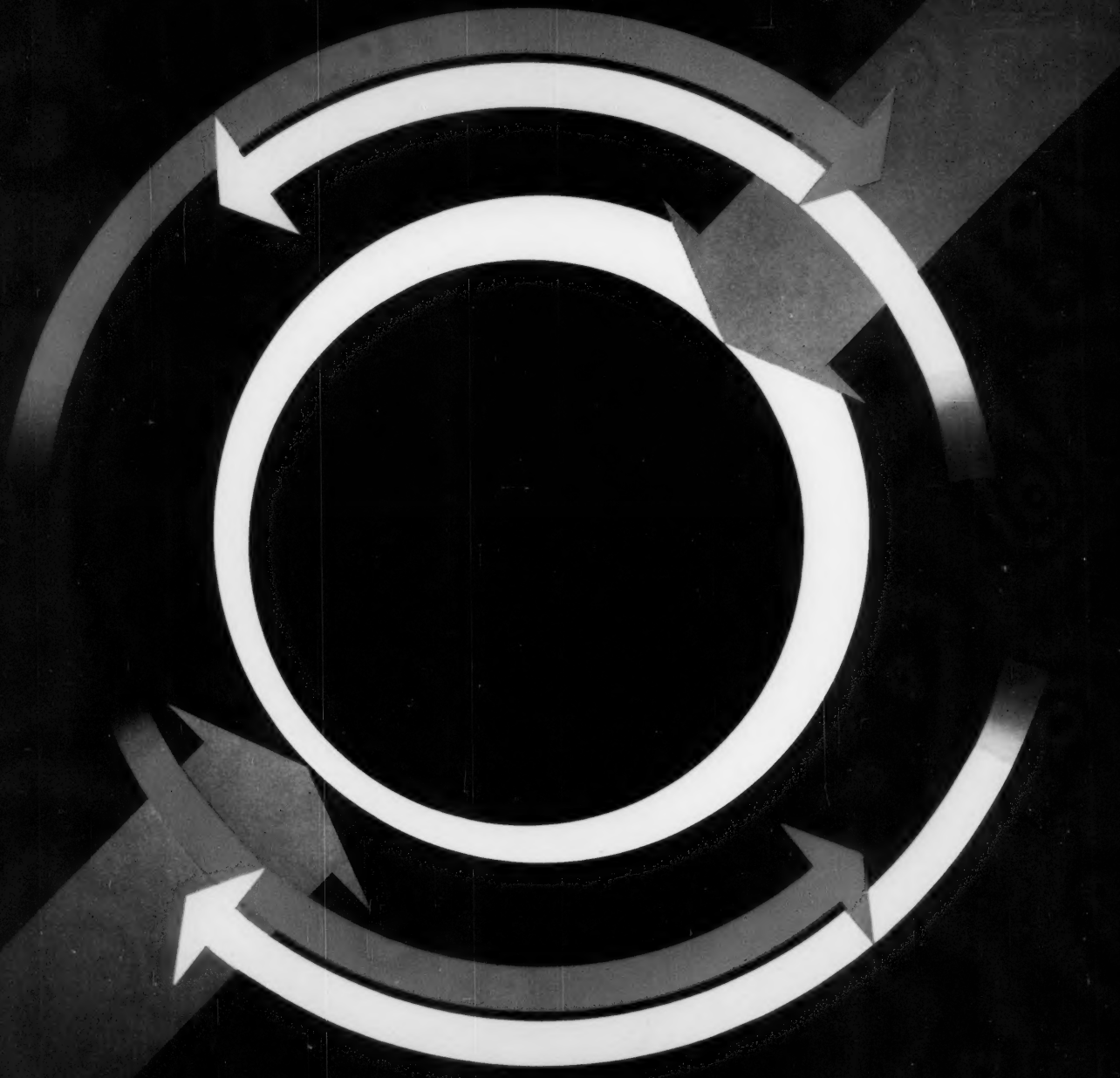
DECEMBER 11, 1958

MACHINE DESIGN

A PENTON PUBLICATION — BIWEEKLY



Oscillating-Load Bearings

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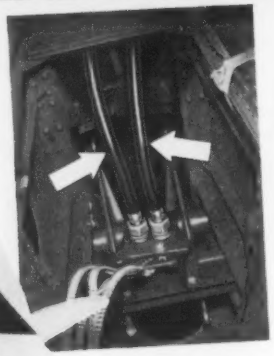
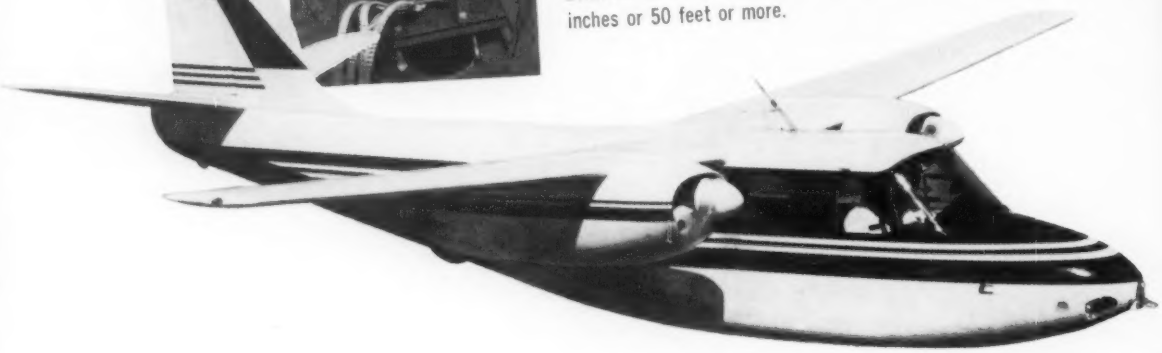


SENSITIVE TRIM TAB CONTROL is provided by S.S.WHITE Remote Control Flexible Shafts in the plane illustrated. Flexible shaft-operated trim tab controls permit sensitive adjustment against strong air pressure with very little effort. S.S.WHITE Remote Control Flexible Shafts are the ideal way to establish control between elements, whether the distance is only a few inches or 50 feet or more.



S.S.White

CONTROL AND DRIVE IDEAS FOR ENGINEERS

Tips on Better Designing with Flexible Shafts

FLEXIBLE COUPLING SHAFT eliminates need for alignment and does not transmit vibration in this variable frequency crystal holder. The coupling shaft is connected to the crystal holder and also to the dial with a set screw, making it easy to assemble the shaft after holder and dial are mounted. S.S.WHITE Coupling Shafts are available for either remote control or power drive.

LIGHTER WEIGHT AND SIMPLER DESIGN are achieved in this brush cutter by the use of an S.S.WHITE Power Drive Flexible Shaft. Cumbersome and troublesome gears are eliminated. Better balance is gained, since the weight of the motor, carried by the operator's harness, is located to give the unit perfect balance for finger-tip control. The unit can be swung easily into any position, high or low. The flexible shaft gives fully dependable service.

WHETHER YOU NEED specially engineered, custom flexible shafts, or standard off-the-shelf shafts, rely on S.S.WHITE. For information on standard shafts, write for Bulletin 5801; for custom-designed shafts, ask for Bulletin 5601.

S.S.White

IN FLEXIBLE SHAFTS

S.S.WHITE INDUSTRIAL DIVISION, 10 East 40th Street, New York 16, New York
Western Office: 1839 West Pico Blvd., Los Angeles, Calif. (Dept. 4)

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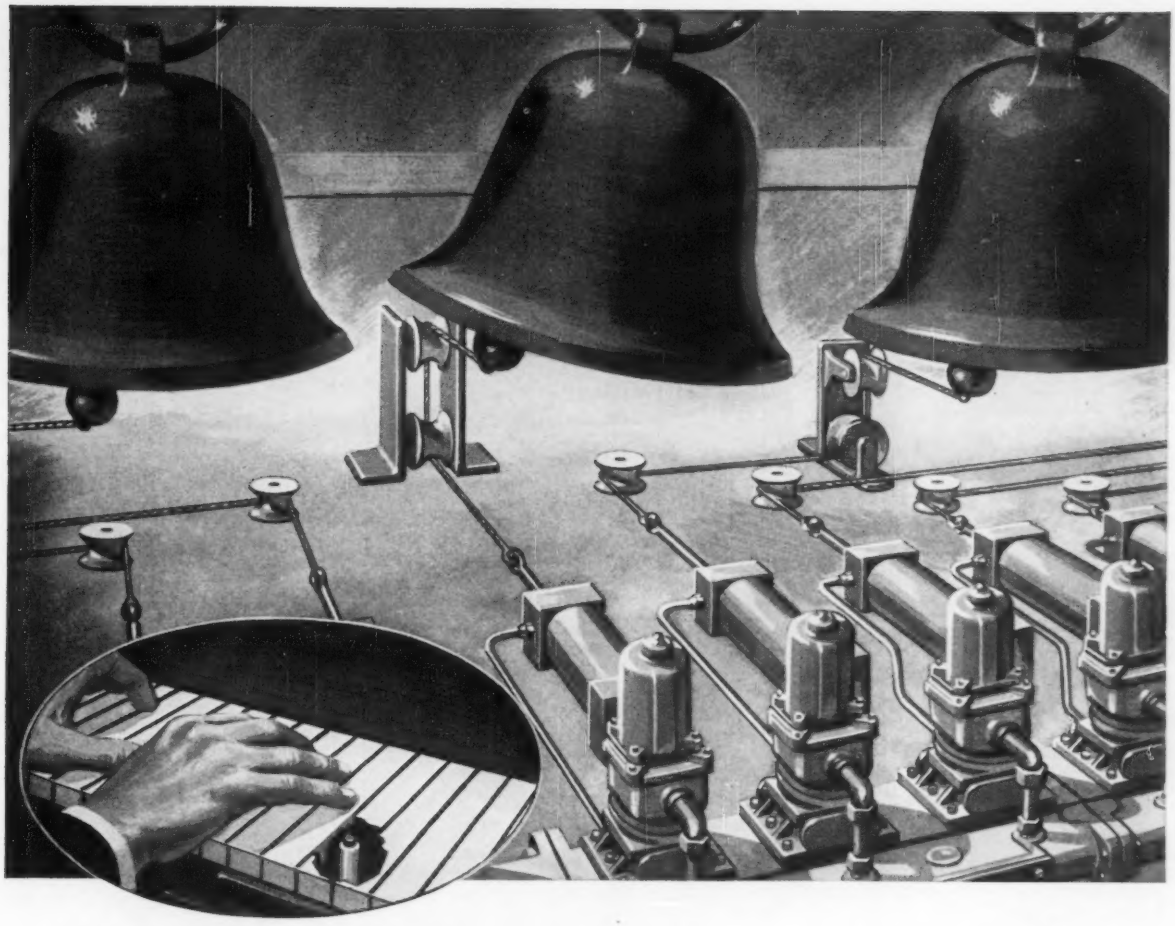


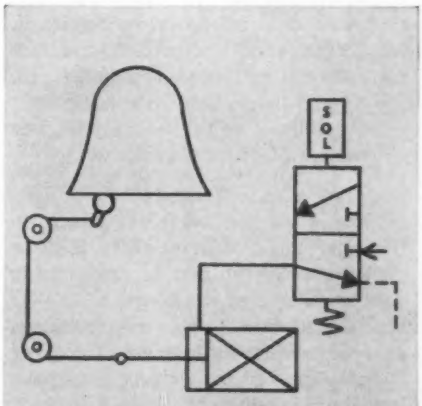
What? Air Power Rings the Bells!

Air powered clappers for the bell tower may be strictly fiction, but . . .

Can you imagine a keyboard that's a set of electrical switches. They operate a set of solenoid valves which in turn advance and retract cylinders. The cylinders, of course, pull the clapper cords. Shows that anything can happen when an air-minded engineer gets in the spirit of the season. But while this is just a flight of the imagination that you aren't likely to see installed in a carillon soon, you might very well want to take advantage of the underlying idea in some of your *plant operations*. Here is the idea:

Just one operator can control hundreds of operations by using solenoid valves.

And these solenoid valves, you'll notice, are manifolded. The manifolding saves piping, space, etc., just as has been possible for years with Ross valves that are operated manually, by air, cams, etc. Incidentally, you won't find this manifold in our catalog . . . it is one of the many refinements and variations of the standard Ross line that make it so flexible. To keep fully aware of the developments continually being made to increase the flexibility of the Ross line, keep in close touch with your local Ross Valve Engineer.



SEQUENCE OF OPERATION

Every time solenoid is energized, bell clapper is pulled against bell.

Ross OPERATING VALVE CO. 109 East Golden Gate • Detroit 3, Michigan

Circle 404 on Page 19

Now from Goodyear—

positive drive

BELTS

—the positive answer to the need for a quality tooth-meshed belt

Here is Goodyear quality in a transmission belt that opens the door to important advances in the design of machines and appliances.

For the Goodyear Positive Drive Belt was developed with the designer in mind—after careful study of his needs by the G.T.M.—Goodyear Technical Man. It makes possible important economies in weight, space and construction—on drives up to 600 h.p. and speeds to 16,000 f.p.m. And, most important, it's completely reliable—built to the notably higher standards of Goodyear quality.

Why not, then, ask the G.T.M. to drop by and give you complete specs on Goodyear Positive Drive Belts. He'll be glad to work with you in determining your best use of standard belts—or special sizes built to your requirements. Just contact him through your Goodyear Distributor—or by writing Goodyear, Industrial Products Division, Lincoln 2, Nebraska, or Akron 16, Ohio.

Goodyear Positive Drive Belts are manufactured under license and according to U.S. Patents 2,507,852 and 2,397,312.

LESS WEIGHT! Pulleys can be light alloys—ideal for portable machines—aircraft components.

LESS SPACE! You can combine small pulleys, short centers and narrow belts of high capacity—a real space-saver.

LESS MAINTENANCE! Since there's no metal-to-metal contact, you can eliminate lubrication systems and devices.

LESS NOISE! In normal speed ranges, noise level is relatively low—no chatter or vibration, either.

LESS HEAT! Elimination of inherent friction—lack of high tension and thin belt construction bar heat build-up.

LESS BEARING LOAD! Since tooth grip—not tension—is important, bearing loads—and bearing needs—are appreciably reduced.

POSITIVE DRIVE BELTS BY

GOODYEAR 60 ANNIVERSARY

THE GREATEST NAME IN RUBBER

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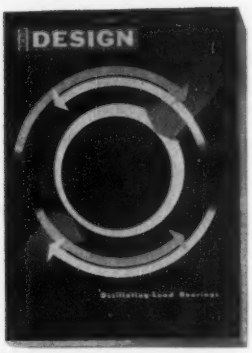

Front Cover: Designing a bearing in which the load oscillates—as depicted by artist George Farnsworth—requires some rather special design methods, covered in a practical fashion by Donald J. Myatt in his article starting on Page 133.

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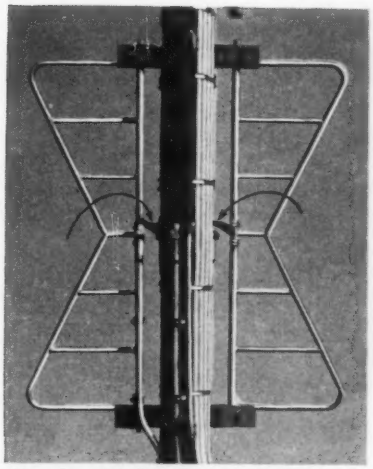
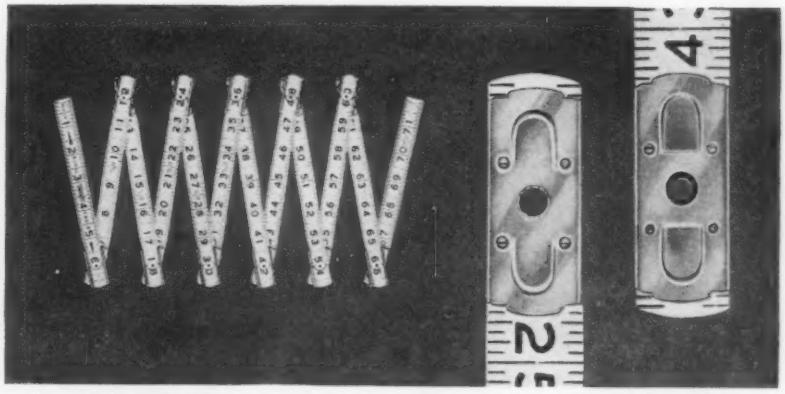
TRY A FRESH APPROACH

Don't just take your metals for granted—specify the properties you need. The Man from Anaconda may come up with some very interesting answers.

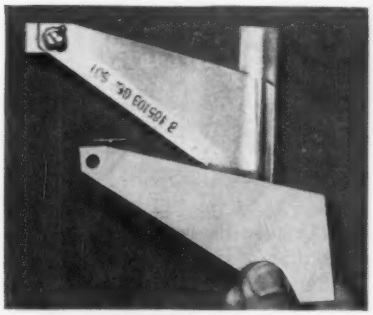


Up where TV broadcast antennas stand, normal wind causes flexing of metals. So jumpers between coaxial cables and radiators must be resilient – beside being conductors, giving some structural support. Ordinary phosphor bronze seemed adequate, but there were fatigue failures.

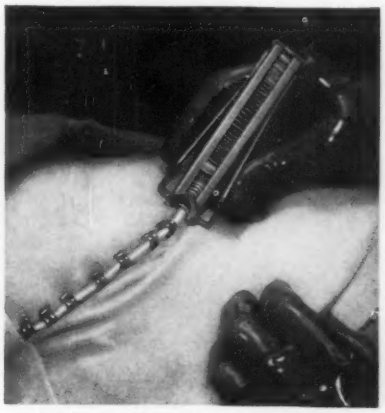


To stimulate sales of its top-quality folding rule, and to meet Navy specifications, Eagle Rule Mfg. Corporation sought a metal for rule joints that would resist wear and corrosion, and provide the proper spring tension. Phosphor bronze, which had these qualities in excess of needs, cost too much.

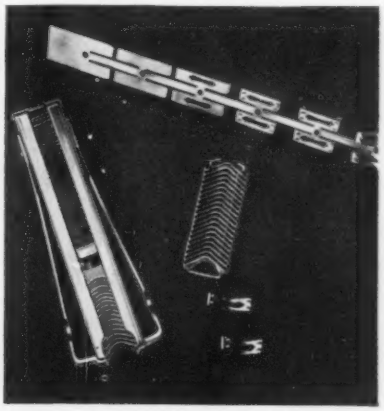
American Brass suggested three alloys. Eagle Rule chose Ambronze-420 (88 Cu, 11 Zn, 1 Sn) because rule joints of this alloy met all requirements, withstood 400,000 cycles in wear test (Navy required 7000). It cost only pennies per pound more than yellow brass, much less than phosphor bronze.



RCA listed desirable properties of phosphor bronze – added *extra*-high endurance, *extra*-long fatigue life. American Brass suggested Duraflex®, Anaconda superfine-grain phosphor bronze. RCA tried it, found it the answer—at no extra cost—specified Duraflex to the manufacturer, Dielectric Products Engineering Co., Inc., Raymond, Maine.



Technical Oil Tool Corp. asked Anaconda to help select the metal for a new magazine-type clip used to close surgical incisions. The metal had to provide the right tension to hold edges together, yet open easily–form readily, hold sharp die-cut edges, be proved in surgical use.



American Brass technical specialists suggested Nickel Silver, 18%-719 as best suited to meet all requirements. Autoclip, shown in use above, is the result. Incisions are held together with least damage to tissues. Surgeons can work faster in applying and removing clips.

STARTING with 93 standard alloys, The American Brass Company can make minor variations in composition, fabrication, and annealing to provide an almost unlimited number of combinations of useful properties. When new or unusual problems arise, ask for the help of the Technical Dept. in selecting the right metal. For such help or a copy of Publication B-32, "Anaconda Copper & Copper Alloys," write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario, Canada. 5850

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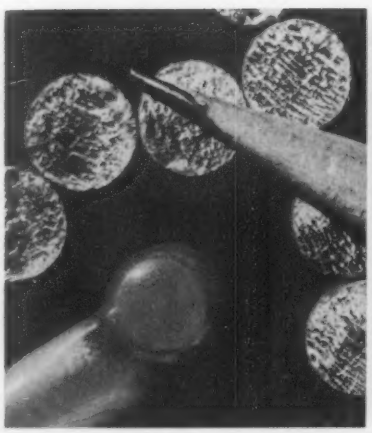
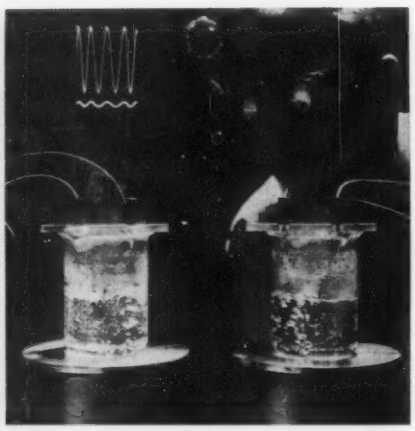
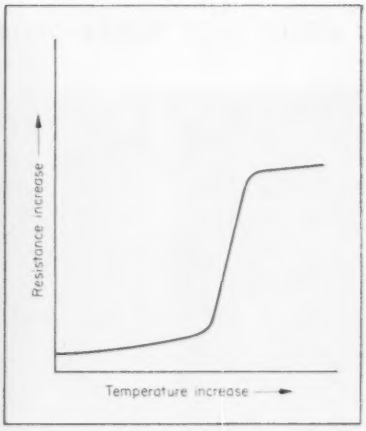
ENGINEERING NEWS

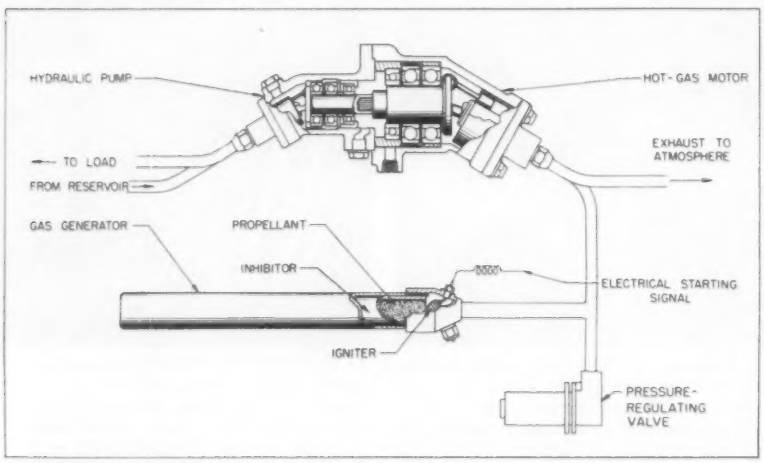






Heat Cuts Off Current in Ceramic Pills

Resistance of a ceramic button the size of an aspirin tablet jumps by a factor of twenty as it is heated through a predetermined critical temperature. Quantitative figures for the button (called Guardistor) have not been released by the developer, Westinghouse Electric Corp., Pittsburgh, but resistance vs. temperature curves follow the general form shown (right). To show narrowness of the range, Westinghouse submerged two Guardistors in constant-temperature baths (center). In boiling water (100 C), a button passed twenty times the current of the button submerged in boiling ammonium chloride (112 C). Resistance returns to previous level when buttons are cooled through the critical range. First application of Guardistors will be as temperature sensors in electric motors. Included in the windings of the motor, they will accurately reflect the condition of the motor itself rather than any nearby variations.



Hot-Gas Motor For Short-Term Power

An axial-piston motor, driven by gases from burning solid or liquid propellants, is the heart of a promising new auxiliary-power unit for missiles and manned space craft. Designed by Vickers Inc., Detroit, the hot-gas motor supplies short-term power for hydraulic systems. It has several outstanding advantages: Rotational speed of the motor closely matches rotational speeds of electrical generators and hydraulic pumps—eliminating gear reduction usually required with high-speed-turbine drives. Also, the motor case is filled with hydraulic fluid, providing a built-in lubricating system for bearings and pistons. The fluid doubles as a heat sink for relief of rotating parts that contact the hot gases.

Seventh-Decimal Measurements Predicted in Ten Years

Refined Units Include Jiffies, Barns, Sheds

NEW YORK—Measurement accuracy of 0.0000001 in. will be attained in the U. S. within the next 10 years, according to Louis F. Polk, president of Bendix Aviation's Sheffield Corp. Polk made his prediction at the recent Ninth National Conference on Standards, sponsored by the American Standards Association.

He pointed out that machine tools and measuring equipment now in use permit volume production of precision parts to an accuracy of ± 0.000005 in. "But in the aircraft and missile fields," he said, "we have practical requirements for seventh-decimal-place accuracy right now . . . for making such parts as gyros, control systems, power linkages and various sensing devices."

The Bendix official said advanced research in nuclear energy is devel-

Please direct inquiries to advertiser, mentioning MACHINE DESIGN→

. . . Fluid Power news

REPORT NO. 12,103
"HYTAC"* SYSTEMS ON NEW PAPER MACHINE

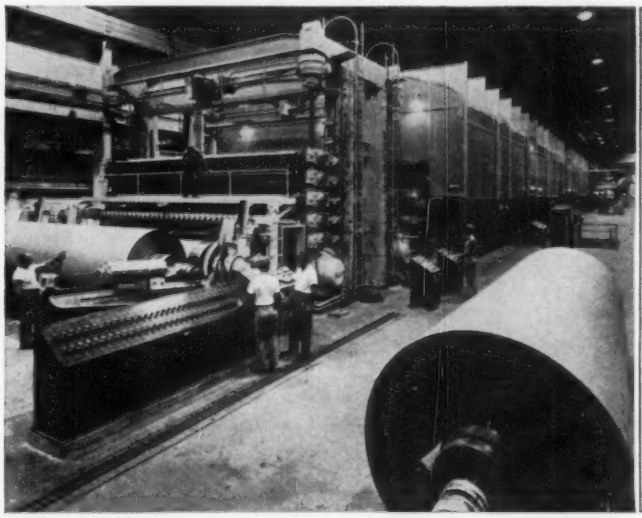
From Oilgear Application-Engineering Files

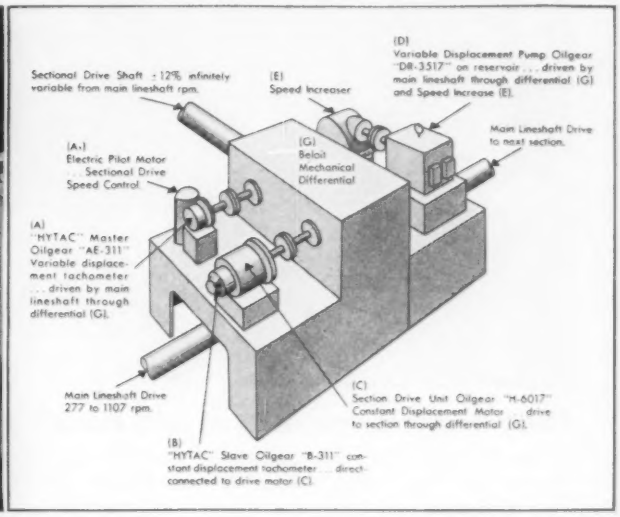
HOW OILGEAR *"ANY-SPEED"* DRIVES ON NEW PAPER MACHINE ACCURATELY CONTROL SECTION SPEEDS

USER: *West Virginia Pulp and Paper Company (Westvaco) (Builder—Beloit Iron Works, Beloit, Wisconsin)*

DATA: Systems to individually vary and accurately control speeds on four sections of a new, 264-in., $25,000,000 paper machine that will produce up to 225 tons daily of a revolutionary, patented, smooth, extensible kraft sheet. Machine is powered from a block-long main lineshaft with mechanical differentials at each section. Main lineshaft speed will vary over a 4:1 range—from 277 to 1107 rpm.

REQUIREMENTS: 1. A system that, when applied to each of four mechanical differentials, will provide individual, precision-controlled, infinitely variable increase or decrease of 10% over or under main lineshaft speed—as selected from 2 local, and 7 remote push-button stations. 2. Each system to maintain selected speed for its section within ±0.25% max. variation over a 50% load change at max. lineshaft speed. 3. Systems must also be: a. Compact. b. Impervious to moisture and daily high-pressure "wash-down." c. Thrifty on electrical power input. d. Trouble-free for continuous, heavy-duty, full-production paper machine drive service.



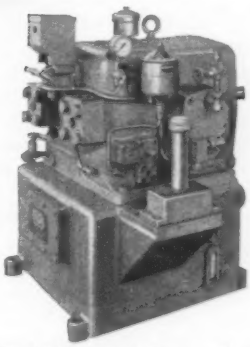

(D) Variable Displacement Pump Oilgear "DR-3517" on reservoir . . . driven by main lineshaft through differential (G) and Speed Increase (E).
Sectional Drive Shaft ±12% infinitely variable from main lineshaft rpm.
(E) Speed Increaser
Main Lineshaft Drive to next section.
(A1) Electric Pilot Motor . . . Sectional Drive Speed Control.
(G) Beloit Mechanical Differential
(A) "HYTAC" Master Oilgear "AE-311" Variable displacement tachometer . . . driven by main lineshaft through differential (G).
Main Lineshaft Drive 277 to 1107 rpm.
(C) Section Drive Unit Oilgear "H-6017" Constant Displacement Motor . . . drive to section through differential (G).
(B) "HYTAC" Slave Oilgear "B-311" constant displacement tachometer . . . direct-connected to drive motor (C).

SOLUTION: *Application-Engineered* Oilgear *Hytac** (hydraulic tachometer) controlled drives provide precise, individual speed control on each of four sections—3rd dryer, 1st calender, 2nd calender, and winder reel of Westvaco's new #3 kraft machine shown above. Drawing, above right, shows components of typical sectional drive. *These highly accurate, compact, heavy-duty systems have met or exceeded all originally specified requirements.* Examples: 1. Specified ±10% infinitely variable sectional speed control range exceeded by providing ±12% in actual operation. 2. Selected speeds are maintained within specified limits *regardless* of load change. 3. Production speeds increased to over 2000 fpm. Important "Oilgear-plus" features are: 1. Dual winder control that, with the mere flip of a control panel switch, converts winder drive from speed-controlled to tension-controlled . . . speed control prevents tearing the tail strip when starting a new core, while tension control provides good roll quality at full sheet width. 2. Cushioned, controlled acceleration and deceleration. 3. Positive overload protection. 4. Pressure and flood lubrication with continuous power fluid filtration.

OPERATION: Fluid from master tach (A) gives section drive speed command to control on pump (D). Slave tach (B) feeds back a flow signal proportional to actual section drive speed. When main lineshaft speed is increased or decreased, fluid flow from master tach (A) automatically increases or decreases to command section drive to follow lineshaft speed change. Through local or remote pushbutton stations connected to electric pilot motor (A_1) on master tach (A), operator can increase or decrease speed of each *Hytac* section infinitely up to 12% of prevailing lineshaft speed.

A second Westvaco kraft machine will have an *Application-Engineered* Oilgear Controlled Motion System to cover a 10:1 lineshaft speed range, and a wider sectional speed range adjustment.

*"HYTAC" Systems—An Oilgear Trademark



Left: Oilgear Sectional Drive Pump (D) with integral reservoir. *Right:* Oilgear Sectional Drive Motor (C) with direct-connected *Hytac* slave (B) to left.

Fluid Power drives and controls were selected after three years of development on this process and machine—from a 2-in. table model, through a 15-in. laboratory model and 60-in. pilot model. Conventional variable speed drives could not provide the sectional speed control required. *"Equipped with the most advanced precision controls known to the industry . . ."*—is the statement Westvaco has made concerning their new #3 machine.

. . . for the lowest cost per year—it's Oilgear!

For similar practical solutions to YOUR linear or rotary Controlled-Motion problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

THE OILGEAR COMPANY
Application-Engineered Controlled Motion Systems
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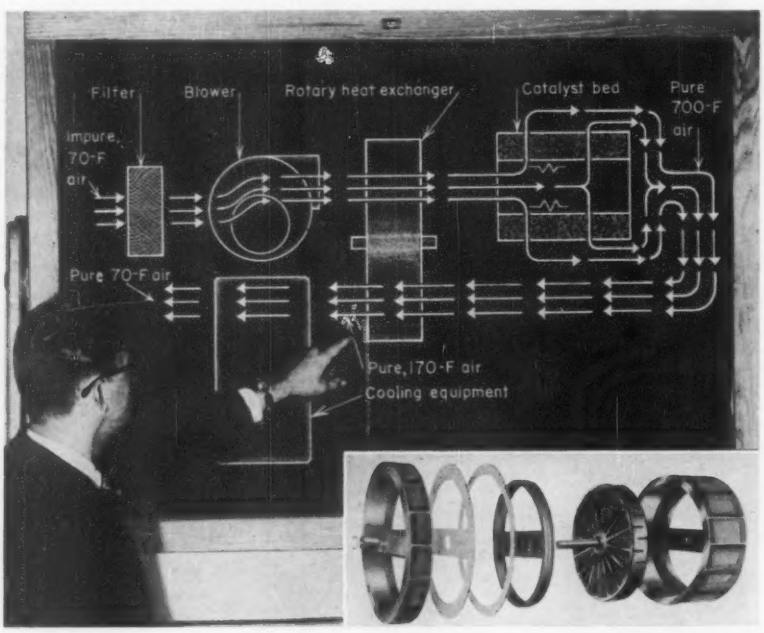
oping new concepts of measurement complete with new jargon. For example, he cited the estimated weight of an electron as one-thirtieth billion, billion, billion billionths oz. A "jiffy," he said, is the time required for light to travel 1 cm, a "barn," which is an area used to measure atom action, is the part of a sq cm that would be expressed by the fraction 1 over 1 followed by 24 zeros and a "shed" is 0.000001 of a barn.



Rotary Heat Exchanger is Key to Subs' Pure-Air System

A rotary, gas-to-gas heat exchanger, installed aboard the submarines USS Nautilus and Skate, helps provide the most compact submarine air-purifier system ever developed. The system removes carbon monoxide and hydrogen from the sub's atmosphere by heating the air to 575 F and forcing it through a catalyst bed where the offensive gases are oxidized to carbon dioxide and water. Since the catalytic reaction supplies most of the heat needed to sustain the process, the rotary exchanger merely transfers heat from hot purified air to the cooler unclean air entering the catalyst bed. In this manner, power demand is cut from an estimated 40 to 6 kw. At the heart of the rotary exchanger are multiple stainless-steel elements which absorb heat from the catalyst bed. Important also is design of sealing surfaces, which insures seal effectiveness regardless of thermal expansion of the rotor. The unit was designed by Dosimatic Products Inc. and is being manufactured commercially by Air Preheater Corp., New York

Faster-Setting Silicone Rubber

MIDLAND, MICH.—A fast-setting silicone rubber in easy-to-apply liquid form vulcanizes in 30 min. This is about 20 times faster than conventional RTV (room-temperature vulcanizing) silicone rubbers, according to Dow Corning Corp., developer of the new material.

Called Silastic RTV 502, the silicone retains flexibility from −70 to 500 F, and has good electrical insulating properties. Like regular heat-cured silicone rubber, it also resists weathering, moisture, ozone and corona.

According to Dow, Silastic RTV 502 is suitable for sealing and caulking metal-to-metal and metal-to-rubber joints; potting and encapsulating electrical and electronic parts; as a mold or impression material for making prototype parts; and as a shock and vibration absorber for delicate components.

Topics

Opportunity will pound increasingly louder on the doors of engineers, scientists, and technicians during the next decade. In a survey conducted by the Scientific Apparatus Makers Association, representatives of the nation's 500 largest firms predicted their needs for technical personnel in 1968. Increases of 25 per cent or more are expected by 300 of the firms, 50 to 100 per cent by 65, and 200 per cent by 135 companies.

• • •

Decorator's dream is a machine built by Sun Chemical to provide a selection of 1152 colors and shades of paint. Nine basic colors are placed in the machine by the paint dealer; he turns a couple of dials and the machine measures and blends the proper ingredients to produce the desired shade.

• • •

Crime detection in an aerosol can is provided by a quick-drying plastic spray for reproducing fingerprints. Spraying a dusted print produces a thin film which can be stripped from the object and stored indefinitely in a master record file. Excellent photographic reproductions can be made from the master print. This technique, a development of Atlantic Research Corp., Alexandria, Va., makes sharper reproductions of latent prints than methods now in use. It was originally developed for the Quartermaster Corps for use in identifying war casualties.

• • •

The gentle art of brewing tea is performed automatically by a British-made electrical tea maker, which consists of a water container mounted on top of a ceramic teapot. The user merely puts tea into the pot and water into the container and "switches on." The appliance warms the pot, heats the water to boiling and ejects it into the teapot, then switches itself off, leaving the tea to brew.

• • •

Not like mother used to bake: Today's housewife can roll out her pie mix with a pastel plastic rolling pin. The J. C. Davis Co., Detroit, makes ball-bearing rolling pins of Celanese Fortiflex in pink, yellow, and translucent white.

• • •

Modern design for the abacus has been granted a patent. Stephen Blake, of New York City, developed a "simpler" abacus with rods and counters in groups adapted for multiplication and division, as well as for addition and subtraction. A printed chart beneath the counters designates the functions of each group and their respective factors. Differences in color of the counters also serve to indicate use.

Wanted: Engineers

with an interest in writing

Like to break into an interesting field where you'll make good use of your engineering talents — yet have a chance to develop new skills?

We're looking for several men with engineering experience and a yearning to write or edit. As an editor on MACHINE DESIGN, you would broaden your engineering background in a job that provides stimulating contact with people in many engineering areas.

You don't have to have actual writing or editing job experience, although we expect definite ability in handling the English language. An ME or EE degree plus several years of design-engineering experience would be ideal, but we'll be happy to consider equivalent qualifications.

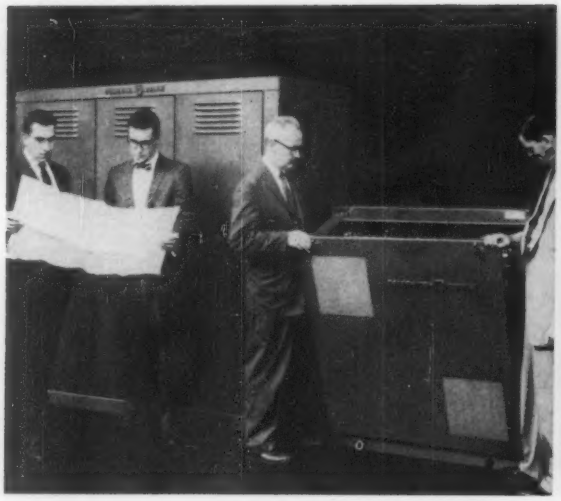
If you've worked in a design-engineering specialty area, we'd like to hear about it. We're interested in any job experience or training in:

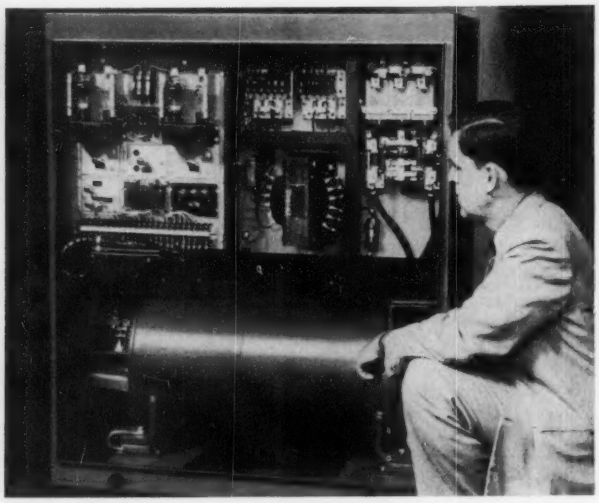
- Mechanical drives, controls, systems
- Mechanical components, assemblies
- Electrical or electronic drives, controls, systems
- Hydraulic or pneumatic systems, drives, controls
- Materials and finishes selection or specification
- Design for manufacture or production design

Our headquarters are in Cleveland. There is opportunity for travel to engineering meetings, expositions, and manufacturing companies. Salary will depend on your background and experience.

If you are interested, send a resume of your engineering background, and any evidence you may have of writing ability (we'll return this if you wish) to: Editor, MACHINE DESIGN, Penton Bldg., Cleveland 13, Ohio.

MACHINE DESIGN





Adjustable-Speed Drive in a Small Package

Smaller motor-generator sets, plus improved cabinet ventilation, are responsible for a 35 per cent reduction in the size of new, packaged, adjustable-speed drives. Developed by Reliance Electric and Engineering Co., Cleveland, the new units are built around completely redesigned ac and dc motors and generators that use improved high-temperature insulation. Control cabinets are pressurized to keep out dust, and all ventilating air is drawn through oil-type filters. Component circuits are embedded in solid blocks of plastic. Photo at left shows size comparison between Reliance's old and new 40-hp drive-control units. Removable front and rear panels, right, permit easy maintenance.

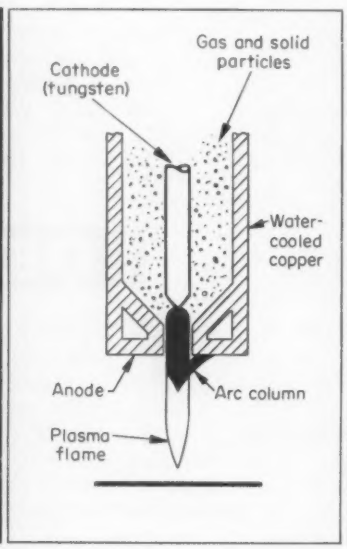
New Torch-Formed Parts Take Heat of Space Engines

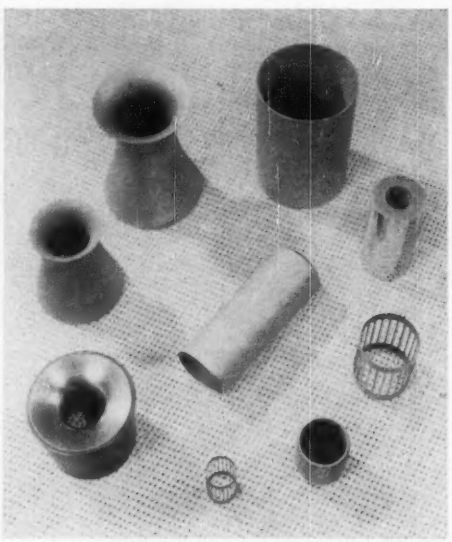
Commercial Plasma-Arc Torch Melts Anything in 30,000 F Jet

NEW YORK—Parts made with a new plasma-arc torch can withstand the terrific temperatures expected in space travel (5000 F in critical spots). Developing temperatures up to 30,000 F, the torch can melt virtually any solid known, including many refractory materials that have been considered unworkable because of their high melting temperature.

The torch has aided the production of experimental rocket and missile parts of pure tungsten or tungsten-coated graphite, crucibles for metallurgical use, electric contacts, and high-density X-ray targets.

In operation, an arc is struck between a tungsten cathode and the water-cooled copper nozzle. Inert gas blasting through the nozzle is ionized in the arc to make the plas-





Nozzle liner for rocket engine (left) is made by depositing tungsten coating on mandrel which is later dissolved out. Tungsten melts at above 6000 F. Drawing (center) shows working of plasma-arc torch. Wire or powdered material is fed into the arc where it is melted and deposited by the plasma jet to make parts like those shown at right. Virtually any material, ranging from aluminum to tungsten carbide, can be deposited by the torch.

CASE HISTORIES

N/D achieves maximum axial and radial rigidity by matching two or three super-precision angular contact bearings having different contact angles. See figures 1 & 2 below.

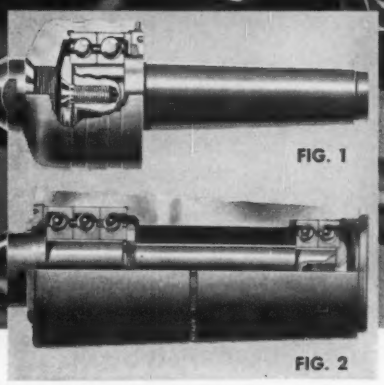


Photo: courtesy Ready Tool Company

Bearing Design Helps Live Center Maker Achieve Accuracy of .000050"!

CUSTOMER PROBLEM:

Live center maker requires bearing design that will help achieve . . . and maintain . . . live center accuracy of .000050", under combination radial and thrust loads.

SOLUTION:

After thorough evaluation of the problem, New Departure recommended N/D pre-loaded, duplex ball bearings. Extensive testing proved these super-precise ball bearings resisted combination radial and thrust loads with minimum deflection. The N/D ball bearings, with medium and high contact angles, are mounted duplex and positively clamped together to assure the optimum, pre-determined preload condition. As work expansion increases the thrust load, radial centering becomes more rigid and accuracy is precisely maintained . . . to less than .000050" total indicator run-out!

When you're working on new designs that call for high precision ball bearings, why not call on New Departure? New Departure's consistent precision is your assurance of the ultimate in accuracy for your design. For more information, call the New Departure Sales Engineer in your area or write Dept. Q-12.

Available through United Motors System and its independent Bearing Distributors.

NEW DEPARTURE

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL

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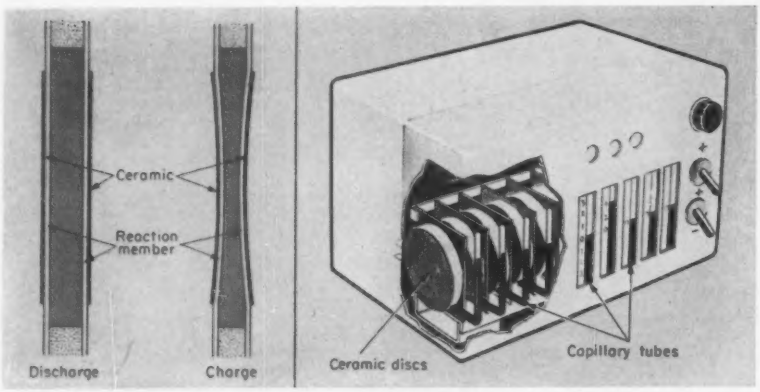
ma stream. Wire or powdered material fed into the arc is melted and deposited by the plasma stream, either on the intended base material in plating operations, or on a mandrel which is later removed by other means. Operators can maintain a dimensional accuracy of ±0.002 in., say developers, Linde Co., division of Union Carbide, New York.



Electric Field Distorts Ceramic-Glass Sandwich

An electrostrictive ceramic, bonded to a metal or glass reaction member, distorts in an electric field like a bimetal element responds to heat. Presence of the electric field contracts the ceramic, developing a strain between it and the reaction member. The effect (left) is a cupping similar to that occurring in thermal bimetal elements. In the application shown (right), fluid is sealed between laminated discs, each composed of a reaction member, electrostrictive ceramic, and a silver frit to distribute the applied charge. Cupping of the discs drives fluid into capillary tubes. Fluid height is measured on scales marked in units suitable to the electrical quantity being measured. Up to ten of these indicators can be installed in less than 6 in. Developer is Mullenbach Div., Electric Machinery Mfg. Co., Los Angeles.

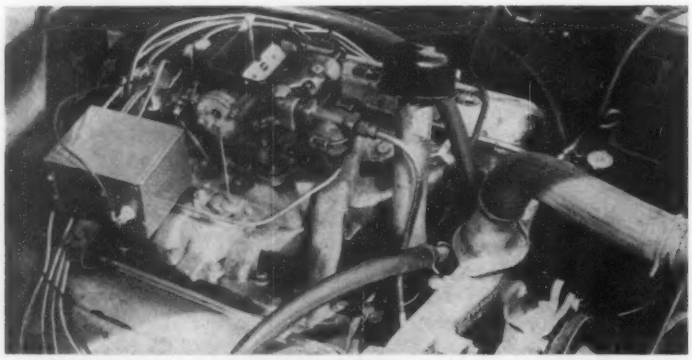
U.S. Librarian Claims Par With Russia on Technical Information

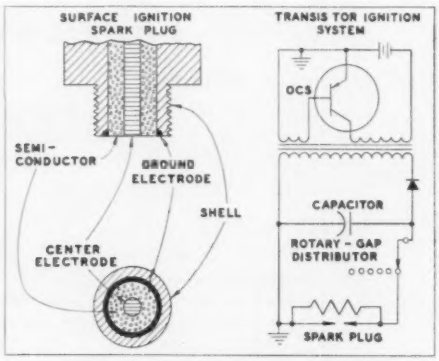
NEW YORK—State operated centralized information services in the USSR are not essentially better than similar privately operated services offered by engineering societies in this country, according to Ralph H. Phelps, director of the Engineering Societies Library of New York. Statements he ascribed to a witness in a senate investigation led him to defend the efficiency, expense, and comprehensiveness of U. S. technical libraries.

Referring to the lack of subject indexes in large sections of Soviet libraries, Phelps claimed that American technical literature can be and is being effectively used. None of the Engineering Societies Library's many abstracting and indexing services is "years behind," he argued.

In answer to a statement that the library's services cost from $1000 to $100,000, Mr. Phelps countered that the library makes many searches each year for fees that range from $100 to $1000—or even less.

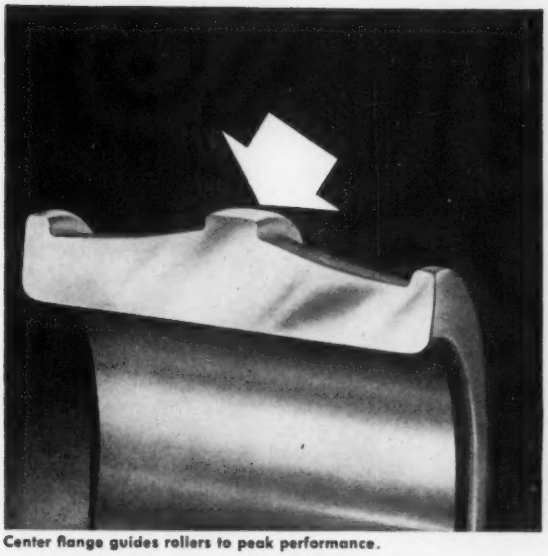
The Engineering Societies Library contains 175,000 volumes, 20,000 maps, 5000 translations, and 10,000 bibliographies and indexes. It is considered the largest and most complete institution of its kind in the nation, if not in the world.



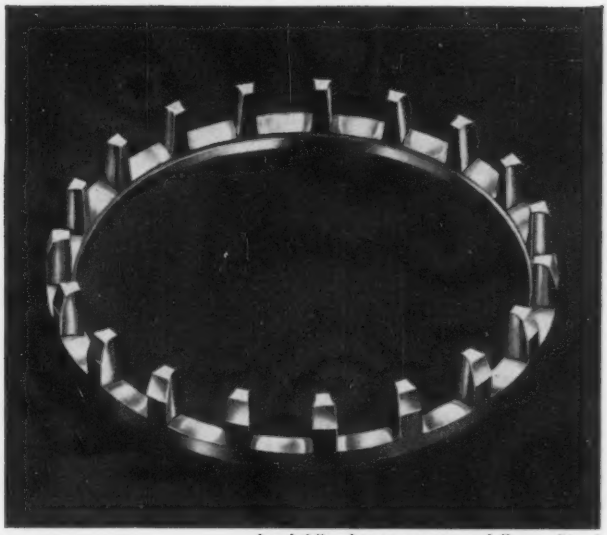


Transistorized Car Ignition

A transistor-equipped primary circuit and surface-discharged spark plugs coupled with a rotary-gap distributor are the main features disclosed by the Electric Auto-Lite Co., Toledo, Ohio in a new type of auto ignition system said to give superior performance in engines having compression ratios as high as 12:1. Surface-discharged plugs have been known since 1937 when one was patented for use in a rectifier, rotary-gap system. Expense and poor performance at high speed limited its transistorized usefulness. Auto-Lite's transistorized rotary-gap model is said to minimize or eliminate these disadvantages. Operating as shown in the diagram, the plug is discharged across the surface of the semiconductive material which ionizes the adjacent air. Since the shortest path is normally followed, erosion is even around the base of the plug. Advantages listed by Auto-Lite are: 1. Low voltage (500-5000 v). 2. Universal heat range. 3. Life to 30,000 miles. 4. Higher compression ratios. 5. More reliability and ruggedness.

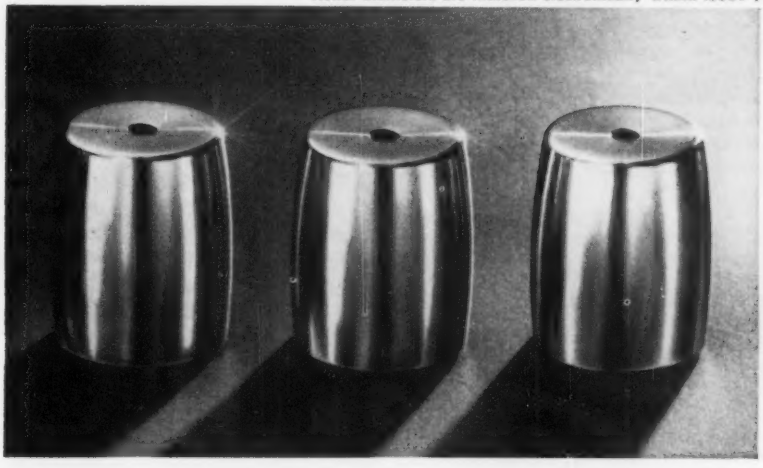


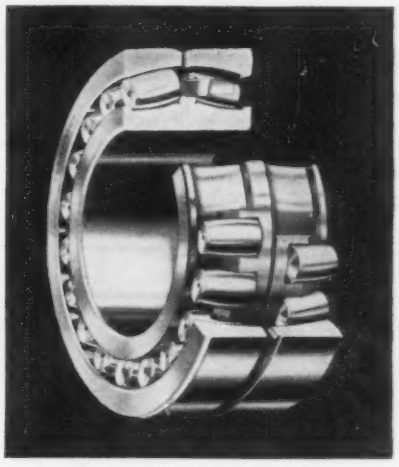
Center flange guides rollers to peak performance.



Land-riding bronze cages are fully machined.

Roller diameters are matched electronically within .0001".





Consider every design feature and you'll choose Torrington!

Torrington has compromised none of the operating design features of its Spherical Roller Bearing, because application experience has proved them essential to superior bearing performance.

There's no substitute for the stabilizing effect of the integral center guide flange. Torrington's asymmetrical roller seeks this flange under load. Skewing and stress concentrations are eliminated. Every roller carries its share of the load, for roller diameters are matched electronically within .0001" for even load distribution.

Rollers are precisely spaced by fully machined land-riding bronze cages that withstand even the high stresses of eccentric service. Two independent cages, one for each row, prevent roller drag and side stresses under thrust loads. Size-stabilized races prevent "growth" or change in dimension in service.

These features mean a cooler-running, longer-lasting bearing. When you buy bearings, look into *every* detail, and you'll choose Torrington. **The Torrington Company, South Bend 21, Ind.—and Torrington, Conn.**

Superior performance features of TORRINGTON SPHERICAL ROLLER BEARINGS:

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The All-Aluminum Car

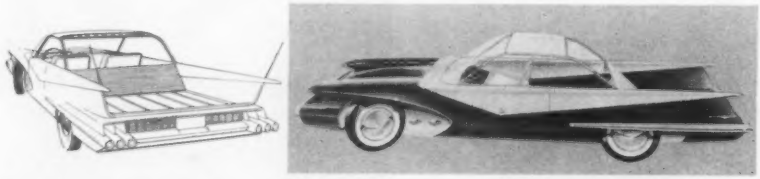
A big producer of lightweight metal asks the automotive industry to consider a radical concept:

Production of this model could begin in one year, says Kaiser. Called the Pele, the car incorporates tried and proved aluminum design and fabricating techniques. The honeycomb grille is fabricated of aluminum strips, first bonded together flat, then expanded to form hexagonal openings. In the hood, a two-section, roll-away door of aluminum extrusions and neoprene joining strips opens for minor servicing. Body panels are stamped aluminum with enameled finish. Side-trim molding is brushed and gold-color anodized. Doors are two-piece die-cast aluminum with sculptured exterior. Functional components of the car, include a water-cooled V-8 engine with aluminum block, an aluminum radiator, and Kaiser-designed integral wheels with cast hub and brake drum.

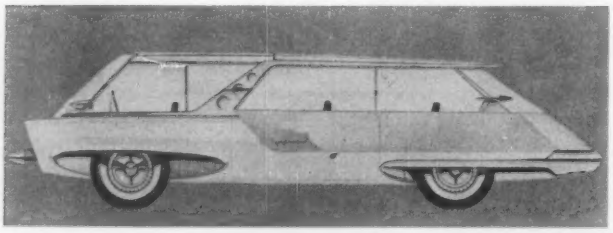
EVERYTHING IS ALUMINUM except tires and windows in Kaiser Aluminum's vision of new cars to come.

The company recently staged an aluminum-car design show for leading automobile stylists. Flashy designs weren't the primary emphasis: Every car part was tagged with a metal specification, and all humps, curves, trunklids, and fins were described in terms of well-used forming and fastening techniques.

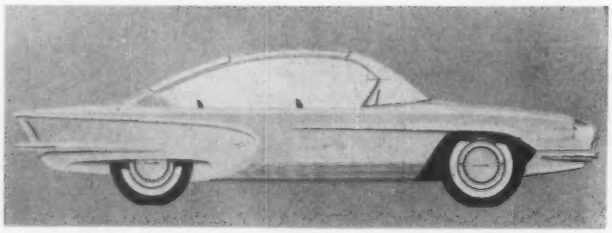
One Kaiser model, called the Pele, incorporates the composite of practical and proved aluminum applications. Its design and construction, says Kaiser, would permit manufacture on existing production lines with no more modification than is required for yearly model changes. The car could be ready for the road in the early 1960s.



Fins form the sides of the cargo box on this four-passenger utility model with sports-car styling. Convertible rear wall of the passenger compartment permits full-height loading with more than 7 ft of flat floor space. Rear window hinges upward, the lower partition rolls down, rear seats fold flush to the floor, and the right front seat is removable. The car is powered by a horizontally opposed, air-cooled aluminum engine with front-wheel drive.



An opposed air-cooled engine is mounted under the driver's seat in Kaiser's aluminum station wagon. With front-wheel drive, the floor is tunnel-free, and can be made of dovetailed aluminum extrusions extending from front seat to tailgate. Front panel and windshield have a die-cast aluminum frame and open for the driver's entrance. A glass roof panel over the driver's section slides back into the rear aluminum panel. The car's frame is formed from a cast-aluminum center support with extruded side rails.



An aluminum approach to the American small car is this lightweight model on a 112-in. wheelbase. It has a rear-mounted, air-cooled, aluminum engine, plus decorative innovations that would lower production costs. Frame is shaped like a shallow pan and built of aluminum stampings, extrusions and castings. It includes side sills, fender skirts, rear-wheel housings, seat risers and floor. Engine and drive units are an integral assembly, removable for servicing.

Rocket LOX Canned for a Year In New Cryogenic Insulation

Provides Standby Fuel Tanks Better Than Vacuum Bottles

NEW YORK—A series of super insulations up to 26 times more efficient than standard vacuum insulations, and capable of holding liquid oxygen for indefinite periods are now in use. Union Carbide's Linde Div. says it is building liquid-oxygen storage tanks for missile stands that will hold the volatile liquid for months and even years with little loss. Liquid-hydrogen and liquid-helium storage containers that need no liquid nitrogen coolant can also be built. The company released no details of the new material other than describing it as a new concept in cryogenic insulation and a major breakthrough in providing standby fuel supplies for ICBMs.

Linde is also using the super insulations in the construction of a large, unvented liquid-helium vessel. A 15-day pressure rise for the vessel will be below 180 psi, and the 26,000-gal tank will be designed to have an evaporation rate of less than 2.6 per cent of capacity per year. A similarly designed tank for liquid hydrogen would lose only 9 per cent per year by evaporation.

New Fluid Tested for Re-entry

FARMINGDALE, N. Y.—Scientists expect a new synthetic fluid, polyphenyl ether, to remain liquid in the long temperature range from 20 to 1000 F. It is being tested for use in hydraulic control systems for manned space flight where re-entry temperatures may run as high as 3000 F and hydraulic fluids are likely to be subjected to 1000 F. A present system will work at 1000 F but not below 230 F. Another system now in use will work from 20 to 700 F. The new fluid is the first to give promise of covering the entire range. Valve control elements in the new system may be sapphires although tungsten carbide balls are now in use. Inconel X replaces steel for valve springs subject to these high temperatures. Research is being done by Republic Aviation Corp., Farmingdale, N. Y.

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Whether you are filing a few hundred or hundreds of thousands of drawings, you will find easily expanded and easily altered Pack Inter-Lock units give you both the accessibility and the flexibility you need for efficient filing.

Ingenious new way to solve drawing storage problem

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The basic unit of a Pack Inter-Lock file is a cylindrical air-tight, dust-tight, light-tight compartment in which one drawing, or many drawings rolled together, or four separate rolls of drawings may be stored. The door of each unit contains a card serving as an index for the drawings inside. Color coded index cards, specially made for the Pack File, can be slipped into the door slot to show the current status of a drawing.

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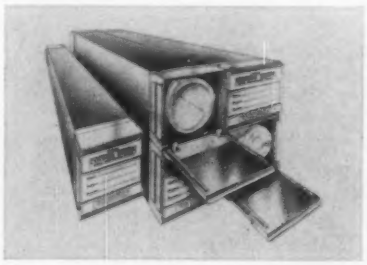

stacks of files into solid units. The stacks are easily altered, permitting great flexibility in arrangements of file space.

Although especially appropriate for storage of inactive or obsolete drawings (with a complete project of up to 30 tracings group-rolled into one compartment), Pack Files are also convenient for current work. The funnel-shaped openings provide fingertip removal or insertion of drawings without damaging them. Excellent protection is assured in the crush-proof, fire-resistant compartments.

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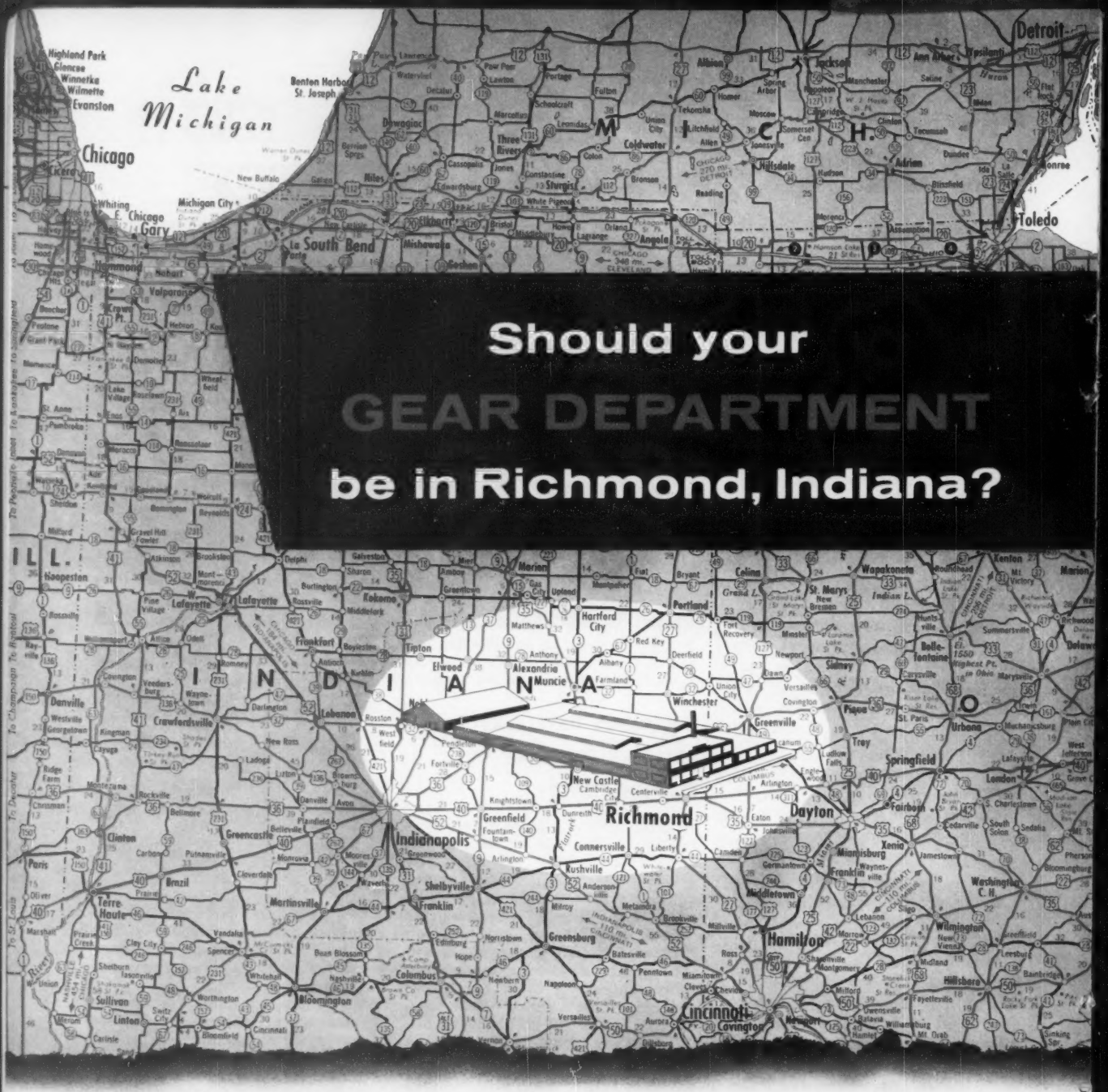
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Decatur
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Penntown
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Napoleon
Hope
Edinburg
Bean Blossom
Nashville
Whitehall
Worthington
Switz City
Linton
Bloomfield
Carlisle
Cincinnati
Covington
Newport
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Minster
Versailles
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Reader Information Service

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EDITORIAL CLIPSHEETS—So you won't have to "clip" this issue, we'll be glad to send a personal copy of any article as long as the supply lasts. Just fill in the page number and title of article in the place provided on the Yellow Card.

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from Skinner in '58

...these answers to your control "puzzles"

L **NEW two-way valve for high flow industrial applications**

At greatly reduced cost, this larger pilot-operated valve permits applications not possible before. Designed for air, oil, water. Features ½" orifice with ⅜" or ½" NPT ports, ¾" orifice with ¾" NPT ports, 1" orifice with 1" NPT ports. Pressure differentials: 5-150 psi. Body is naval forged brass. Diaphragm is fully supported. Available in standard and Explosionproof construction, normally open or normally closed.

A **NEW three-way valve for medium-sized cylinders**

Available normally open, normally closed, directional control and multi-directional, with 5/32" inlet and 5/32" exhaust orifices and ¼" NPT ports. Designed to control air, oil and inert gases. Handles pressures to 125 psi. Body is non-corrosive zinc. Internal parts are stainless steel.

LC **NEW two-way, low-cost, pilot-operated valve**

A smaller, lighter, normally closed valve. Permits full flow through ½" orifice with ⅜" or ½" NPT ports. Will control all common media: air, oil, water, etc. Pressure differentials: 5-150 psi. Forged naval brass body. Uniquely designed diaphragm – fully supported.

R **NEW two-way valve for standard and high pressure applications**

A big capacity, pilot-operated valve with a ¼" orifice and ¼" NPT ports. Designed to control air, water, oil, semi-corrosive materials. Long-lasting, stainless steel internal parts. Forged naval brass body. Available normally open or normally closed. Standard models operate on pressure differentials of 5-200 psi; high pressure normally closed models on 5-1250 psi.

For complete information, please contact our Representative or Distributor near you . . . you'll find him listed in the yellow pages or write us at the address below, Department 42D.

SKINNER ELECTRIC VALVES
THE CREST OF QUALITY

SKINNER ELECTRIC VALVE DIVISION
NEW BRITAIN CONNECTICUT
105 EDGEWOOD AVENUE

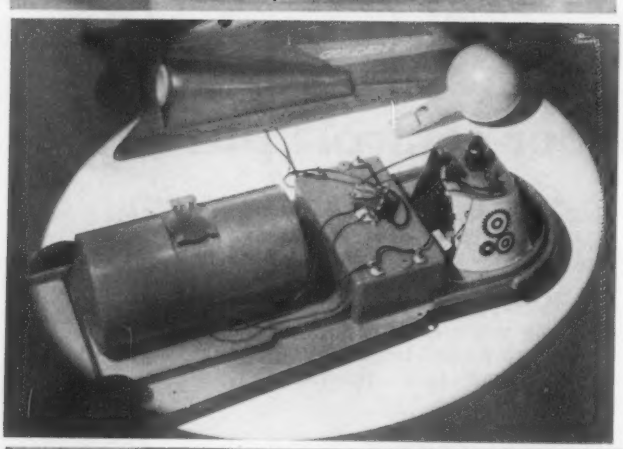
Circle 413 on Page 19

Dry cells by the million spark designs for

3 DC: The Year of

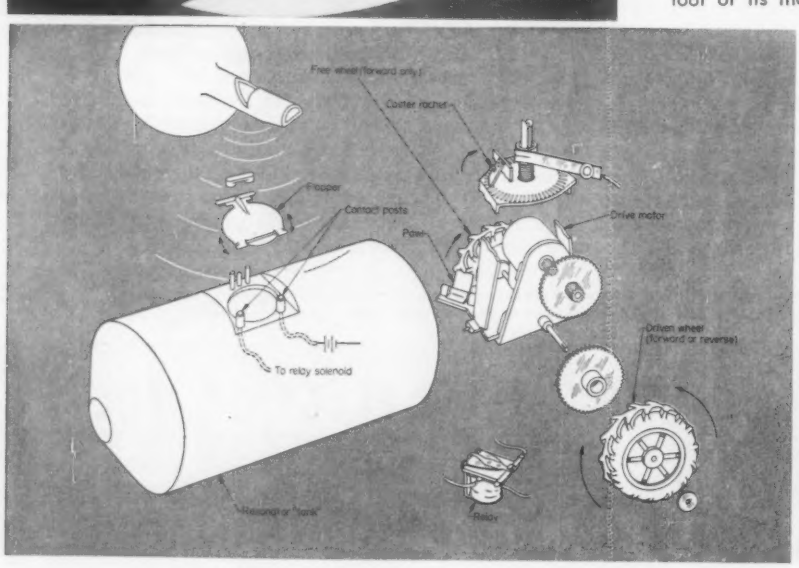
TUNING UP for a cruise to nowhere, the pint-sized outboard heading this page lacks only scaled down exhaust sounds and smells for total realism. No mere maker of tiny tempests in a plastic pot is this 3-v powerplant. Like 75 million other battery-powered toys, it's stirring the affections—and filling the corporate pockets—of the nation's dry-cell manufacturers.

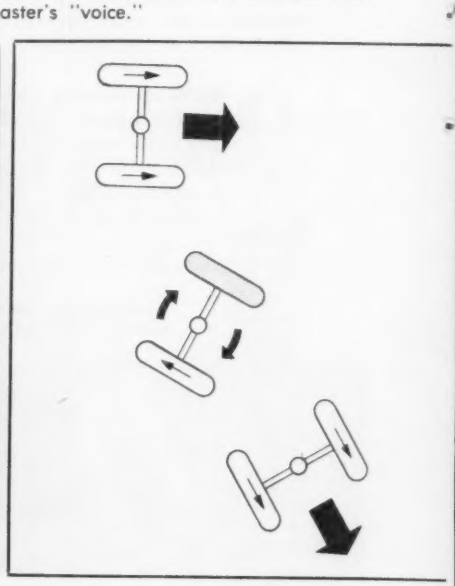
Such affections for the electric "labor-saving" toy are well placed. Toy-industry officials anticipate that '58 retail sales volume will



Helmholtz lends an ear . . .

Suggesting a colorful armadillo, Golden Sonic rolls ahead, reverses, and steers in battery-powered obedience to signals blown on a bulbous whistle. Secret of such tractability is a Helmholtz resonator tank acoustically coupled to a featherweight flapper switch balanced over the tank orifice. Resonator volume is tuned to the whistle; when air rushes in and out sympathetically with signal frequency, the dancing flapper breaks holding current in a forward-reverse relay. Direction of rotation of the powered wheel reverses, and the front caster swivels. Golden Sonic holds the new course until it hears the next toot of its master's "voice."





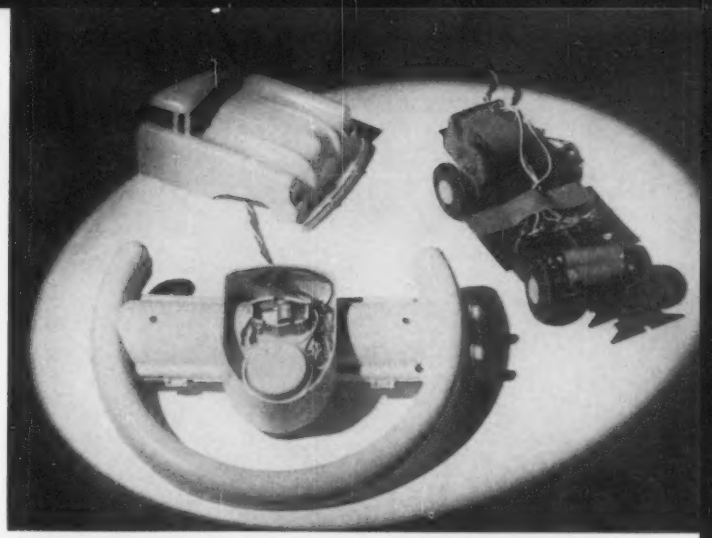
the Powered Toy

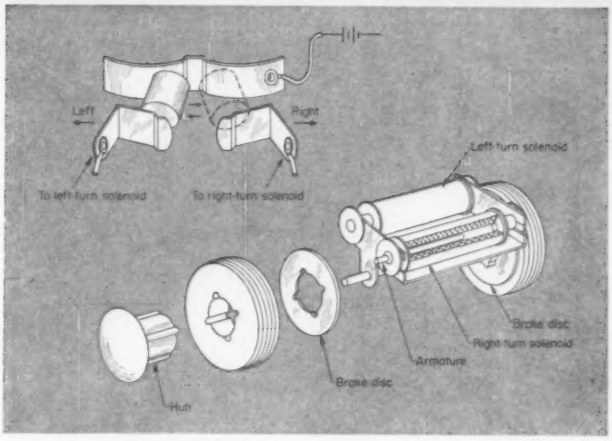
top $1.5 billion. Roughly 25 per cent of this output will turn, twist, and cavort under the power of a pair of common flashlight cells.

This adds up to a high-voltage demand for the standard 1.5-v dry battery: An estimated 60-million cells will be sold this year as original equipment, another 60 million as replacements for cells run down by enthusiastic youngsters. Happily contemplating a market big enough to absorb one-quarter of their combined output, battery makers this year should have no trouble generating the proper Christmas spirit.

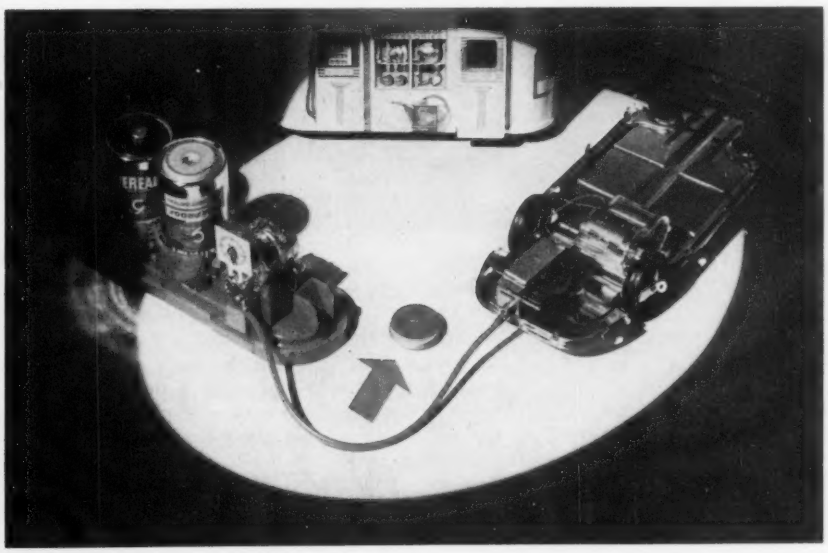
Major U. S. toy builders are also well pleased with the season's sales prospects. Lacking the diversified market of the battery makers, however, they're wrestling as usual with two perennial problems.

First, there's the classic, probably permanent maldistribution of retail sales. It's a fact that roughly 75 per cent of all toys cross the retail counter during the final twenty shopping days before Christmas. This is the root of an abominable

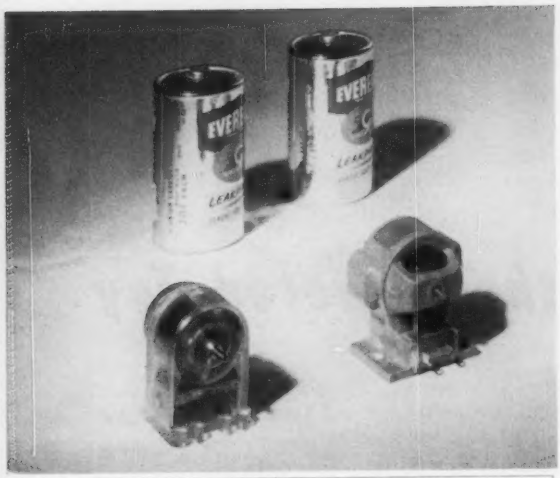


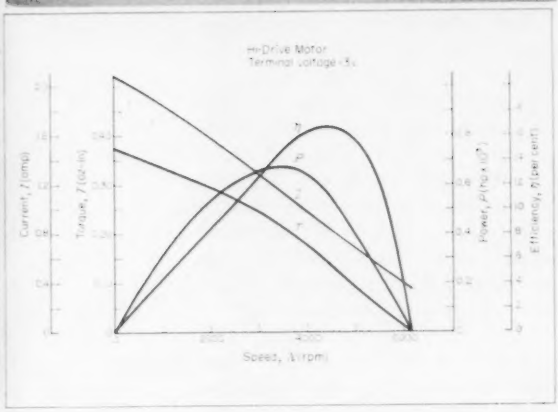


Power-steering option . . .
"Just like Dad's" is the claim for the power-steered Eldina Sportster. The trained eye can, however, detect a few differences in mechanical detail. Key to the operation is a rolling metal slug in the steering-wheel hub. Turning the "free-floating" steering wheel rolls the slug against left or right-turn contact pairs, energizing Sportster's front-wheel braking solenoids. Braking either wheel swivels the front-end assembly and turns the car. Forward or reverse runs are selected by pushbuttons on the steering-wheel rim.



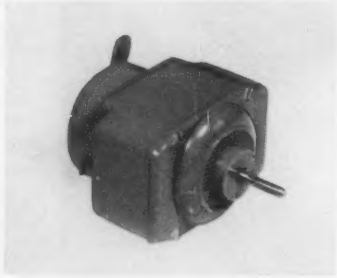
Wie geht's with DEAC?
A Necco-Wafer size rechargeable wet cell product of German Edison Co. (DEAC), powers this German-import car for 10-minute runs on one "refill" from its Electric Filling Station. Current for the charge—obtained by plugging the pump "hose" into the rear end of the car—comes from a pair of series-connected 1.5-v dry cells mounted in the station. During the recharge, a mock fuel-flow indicator on the station spins with the aid of a tiny motor. The car—driven by a Distler ball-bearing motor—runs twice as long as the recharge time. In place of the filling station dry batteries, said to give a playtime operation of 30 to 50 hr, a rectifier can be supplied for use on 110-v house lines.





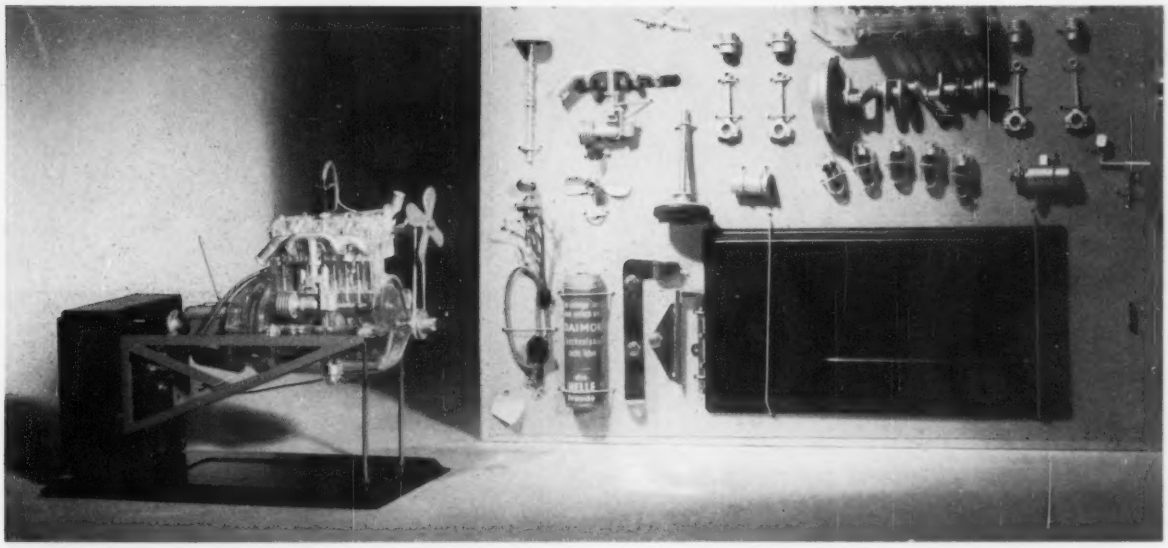
How big is a fleapower?

John Ewashinka—an electrical engineer who works for Wilson's of Cleveland—is a man with a mighty fine touch. He needs it if he's to make sensible prony-brake performance curves for midget motors like Tiny Atom (0.255 millihorsepower) and Hi-Drive (0.675 millihorsepower). Results like those plotted for Hi-Drive come from the tabletop prony brake shown above. The motor is loaded with a length of thread wrapped once around the motor pulley. Friction drag, set by weights at one end of the thread, is measured on a scale that reads in 0.01 lb increments. Wilson's, manufacturers of miniature motors and motor parts, has supplied battery-energized powerplants to the toy industry since 1948. Big users of Wilson-made armatures are HO-gage locomotive makers.



Motors by the millions . . .

Impact of these imported Japanese miniatures—brought in at prices few if any U.S. motor makers can meet—is widespread in the toy industry. One Japanese factory is reported to pour them out at a 70,000-per-day rate. Such imports are found in a great many U.S. built toys, including Golden Sonic, Clermont, and LSU.



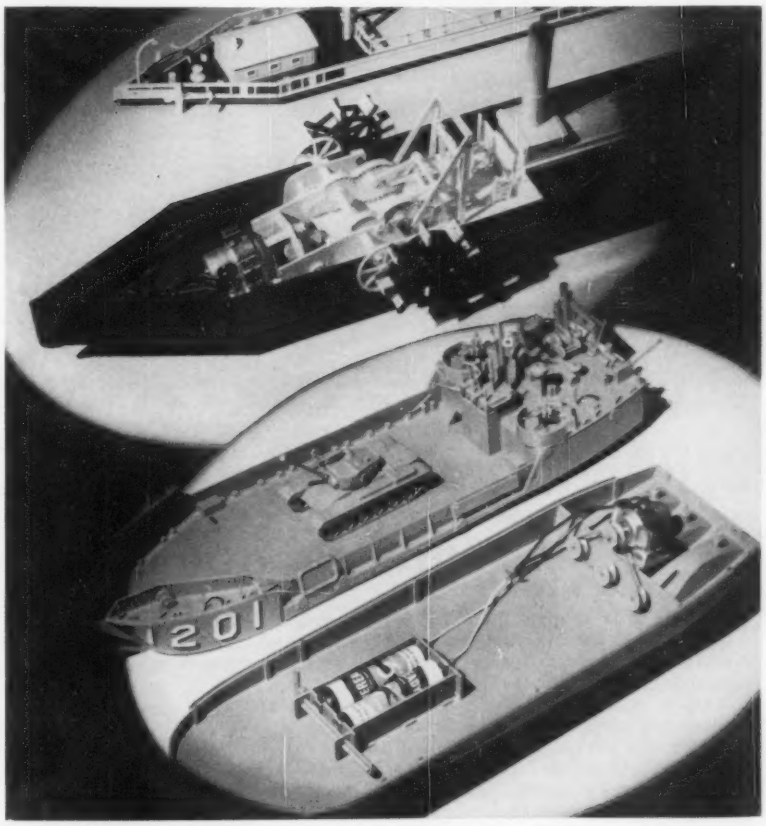
Exploded view . . .
Skills a notch or two above those mastered by the believers-in-Santa set allow a hobbyist to assemble his own transparent plastic auto engine. Pistons and valves move with proper Otto-cycle synchronization, and ignition is simulated by the timed lighting of "spark-plug" lamps.

Fulton's Folly and later . . .
A passel of plastic parts—186 in all—make up an 18-in. powered replica of Fulton's Clermont. Complete with operating gearing and paddle wheels, Clermont gets up "steam" with penlight cells. LSU, with only 163 pieces, uses a rubber band as a drive belt for its triple screws.

production problem. Achieving heavy toy production at reasonable cost for only a few weeks out of the year calls for considerable design and production acumen. Up-to-date fabricating techniques—for example, vacuum forming of plastic parts—have helped.

The second, perhaps more serious problem harassing U. S. toy makers stems from competition offered by foreign imports—particularly those coming from Japan and West Germany. Industry sources have estimated that such imports accounted for roughly 5 per cent of total sales in 1957. A quick scanning of department-store toy shelves indicates that this figure is probably going to skyrocket this year.

Easy solutions to such competition are not obvious; toy-for-toy, few U. S. manufacturers can hope to match the astonishingly low labor and material costs of their foreign counterparts. And, as shown in these pages, U. S. toy designers hold no monopoly on ingenuity. However, by concentrating on clever, high-quality, larger toys—those too bulky for profitable shipping from foreign ports—the nation's toy manufacturers are betting that they can keep for themselves a large part of the market for the here-today-gone-tomorrow world of miniatures.



ACKNOWLEDGMENT

Toys dissected in these pages were supplied through the courtesy of the Higbee Co., Cleveland. Manufacturers are:

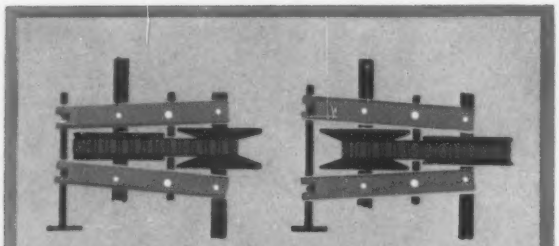
Golden Sonic — Tigrett Industries, Jackson, Tenn.

Eldina Sportster—General Molds and Plastics Corp., Leetsdale, Pa.

Electric Filling Station—Johann Distler K.G., Nuernberg, Germany. Imported by Louis Marx & Co., Inc., New York City.

Transparent Motor—Gescha, Germany

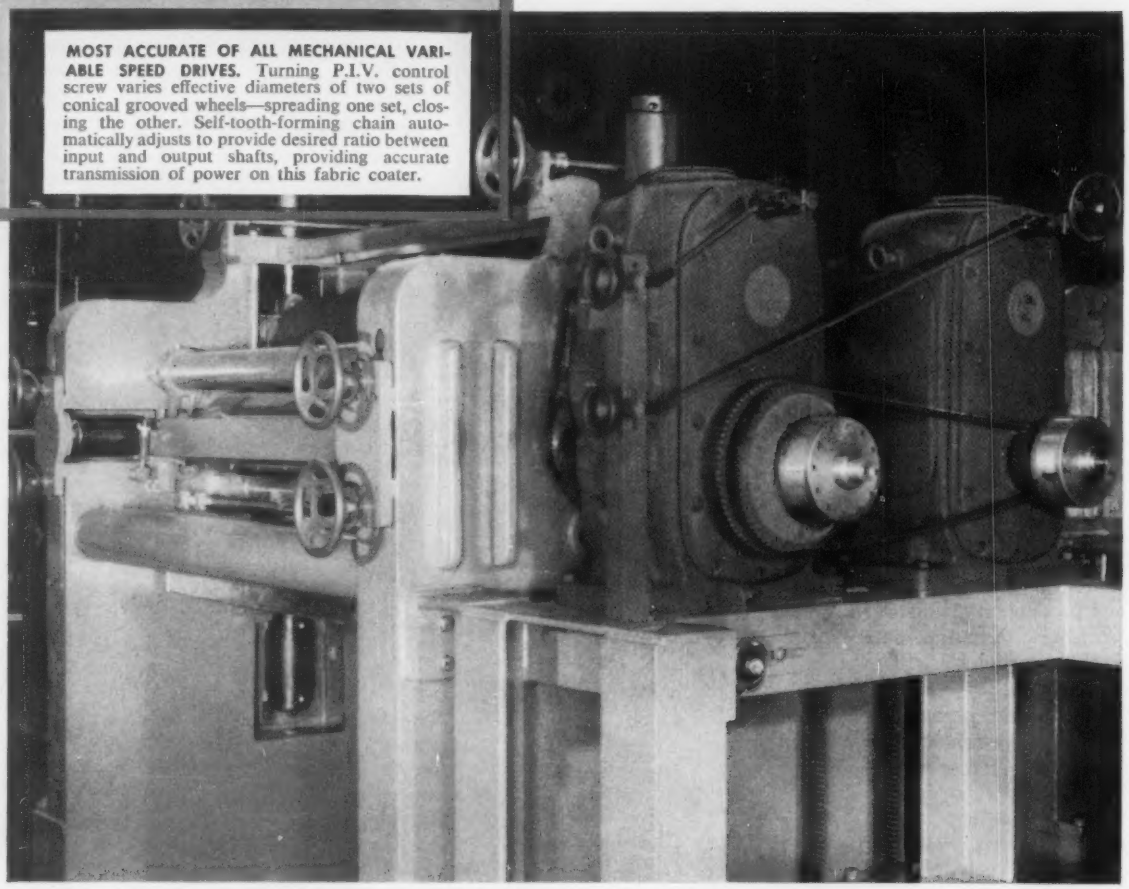
Clermont and LSU—Kits by Lindberg Products Inc., Skokie, Ill.



In principle . . .

in performance . . .

MOST ACCURATE OF ALL MECHANICAL VARIABLE SPEED DRIVES. Turning P.I.V. control screw varies effective diameters of two sets of conical grooved wheels—spreading one set, closing the other. Self-tooth-forming chain automatically adjusts to provide desired ratio between input and output shafts, providing accurate transmission of power on this fabric coater.



for positive, infinitely variable speed control

. . . there's nothing like P.I.V.

Here's a variable speed drive that is truly unique. Unlike conventional designs, Link-Belt P.I.V. with its all-metal chain drive is *not dependent on friction* for transmitting power.

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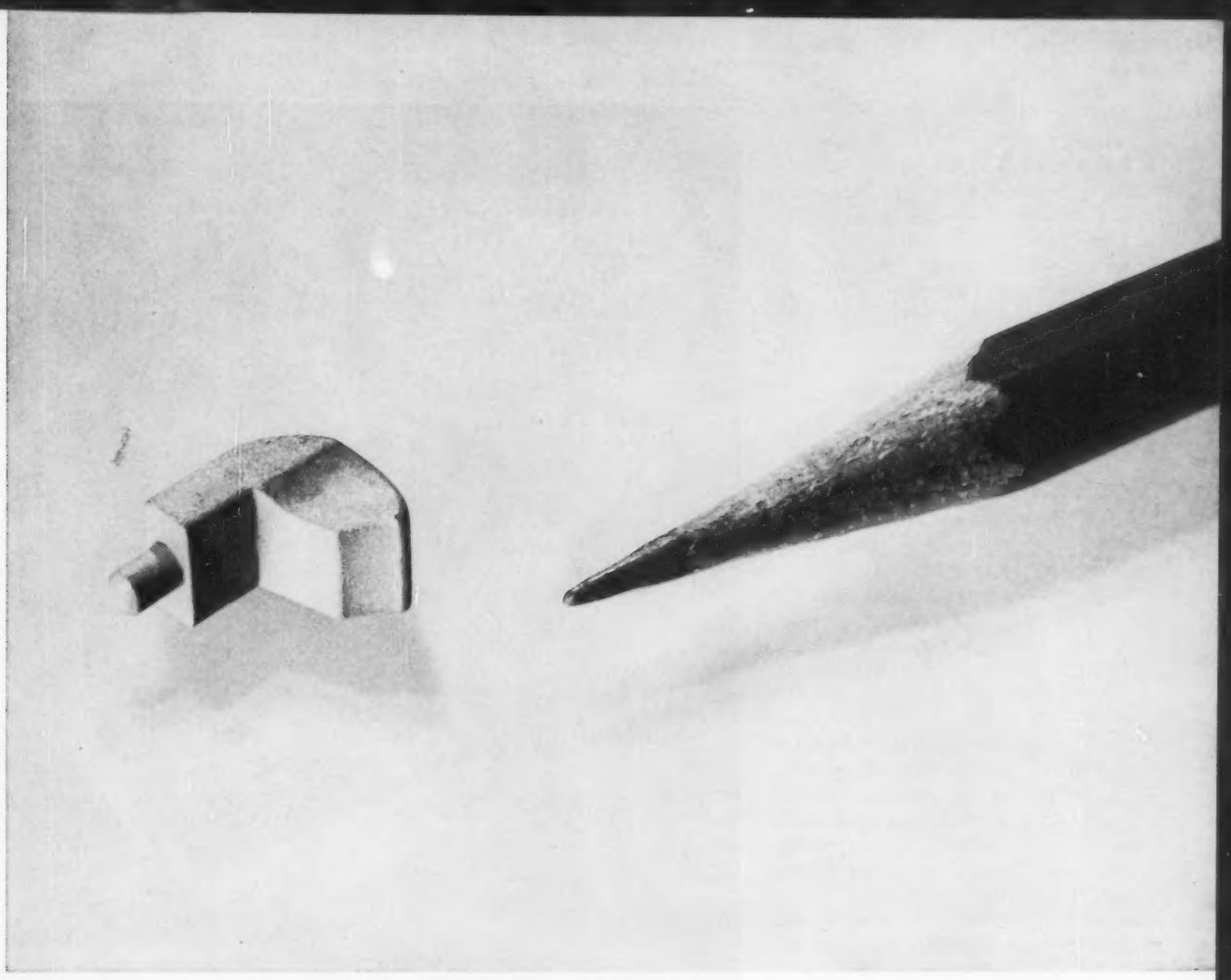


Cold sizing and automation are combined in a new investment-casting technique that produces . . .

CAST MINIATURES *by the Ton*

By J. H. CADIEUX
Vice President
Casting Engineers, Inc.
Chicago, Ill.

AUTOMATION HAS COME to investment casting. A new production process increases output 50-fold for small items, and cold sizes or swages parts to cut dimensional tolerances nearly in half. This production-line philosophy has made investment casting an economic competitor with diecastings, cold-heading and screw-machine production, where formerly it was considered a special process too expensive for run-of-the-mill parts.

Plastic patterns are used instead of wax because of dimensional stability. They are injection molded in multiple-cavity dies, in contrast to earlier individually-made patterns. As many as 20 patterns are produced in one shot. Other automatic methods are used to make investment molds, pour the alloys, and coin, stamp, or swage the resulting castings. By this technique 25,000 to 50,000 close-tolerance parts can be produced per day as opposed to a maximum of 1000 parts per day for conventional investment castings. At ½ cu in. per part this is more than a ton of ferrous metals or titanium per day.

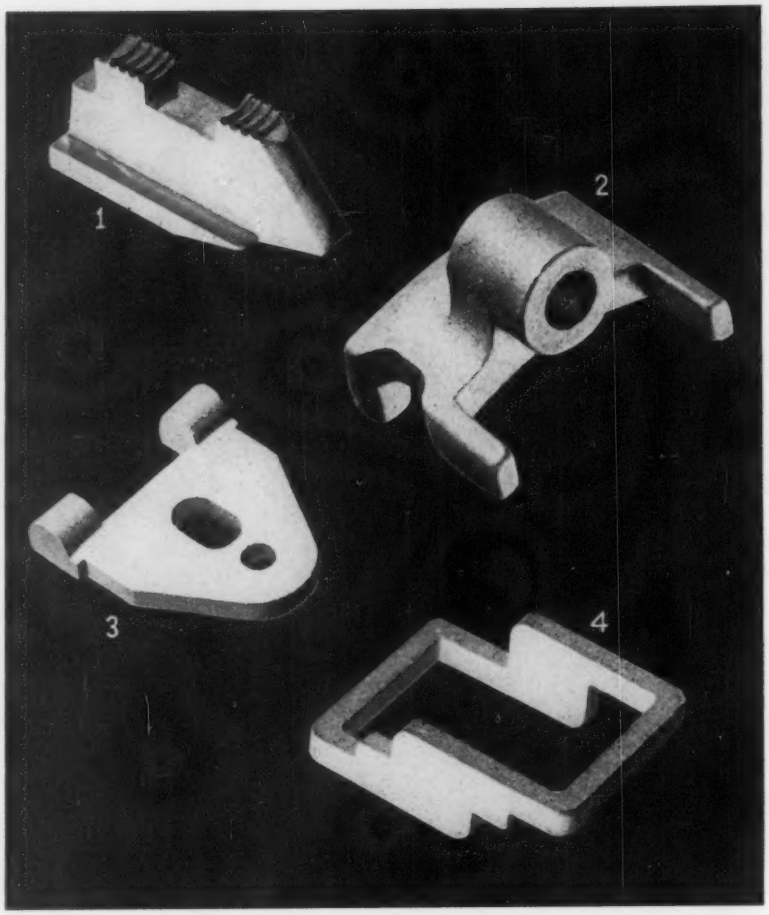
Dimensions as close as ±0.003 in. per in. are produced as standard

practice, while critical dimensions are held as close as ± 0.001 in. per in. (Investment casting industries have always boasted of general tolerances of ±0.005 in. per in. and critical tolerances of ±0.003 in. per in.) Advantages are best realized on units smaller than one cubic inch.

Difficult-to-machine metals find increased usefulness from this process, since the close tolerances obtained reduce or eliminate machining requirements. Suitable metals include high-alloy steels, tool steels, superalloys, and stainless steels. Most nonferrous alloys except high-zinc copper alloys and magnesium alloys can be used.

Superior surface finishes are always found, with some alloys producing finishes as fine as 30 microinches. In one case, teeth were formed 0.010 in. high by 0.010 in. wide with a pitch of 32 teeth per inch. In another application a corner radius of 0.003 in. was held in casting by taking advantage of the extreme fluidity of the material used. Often with harder alloys, sharp edges and corners can be cast, which avoids expensive machining.

Conversion to Minicasting, as the new process is called, does not require any basic redesign of a part; approximately 75 per cent of the objects now being manufactured this way are being produced from the same drawings previously used for other forming methods. The majority of the remaining jobs were redesigned to incorporate details not formerly possible.



Typical products of Minicasting show range of materials and typical cold-finishing processes. Jaw for a riveting gun (1) is cast in 4140 steel. It was sized after casting to hold centerline of rivet central with gripping face. Cam in a limit switch (2) is made of 8620 steel, case hardened. Part was coined after casting to maintain flatness. Legs of the beryllium copper yoke (3) were formed in a sizing die after casting to maintain parallelism. Armature of 1 per cent silicon iron (4) is used in a relay system; the gate stubs were trimmed with stamping dies after forming to maintain uniformity.

Memory Rods Simplify Design of Computer and Guidance Systems

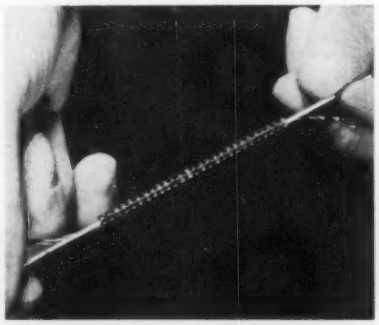
Tiny Magnetic Components Serve Storage, Logic Functions

Compact storage of computer information can be maintained in batteries of magnetic rods that also perform computing and logic functions. Up to ten bits of information per inch can be recorded on these deceptively simple rods, which operate at rates measured in megacycles.

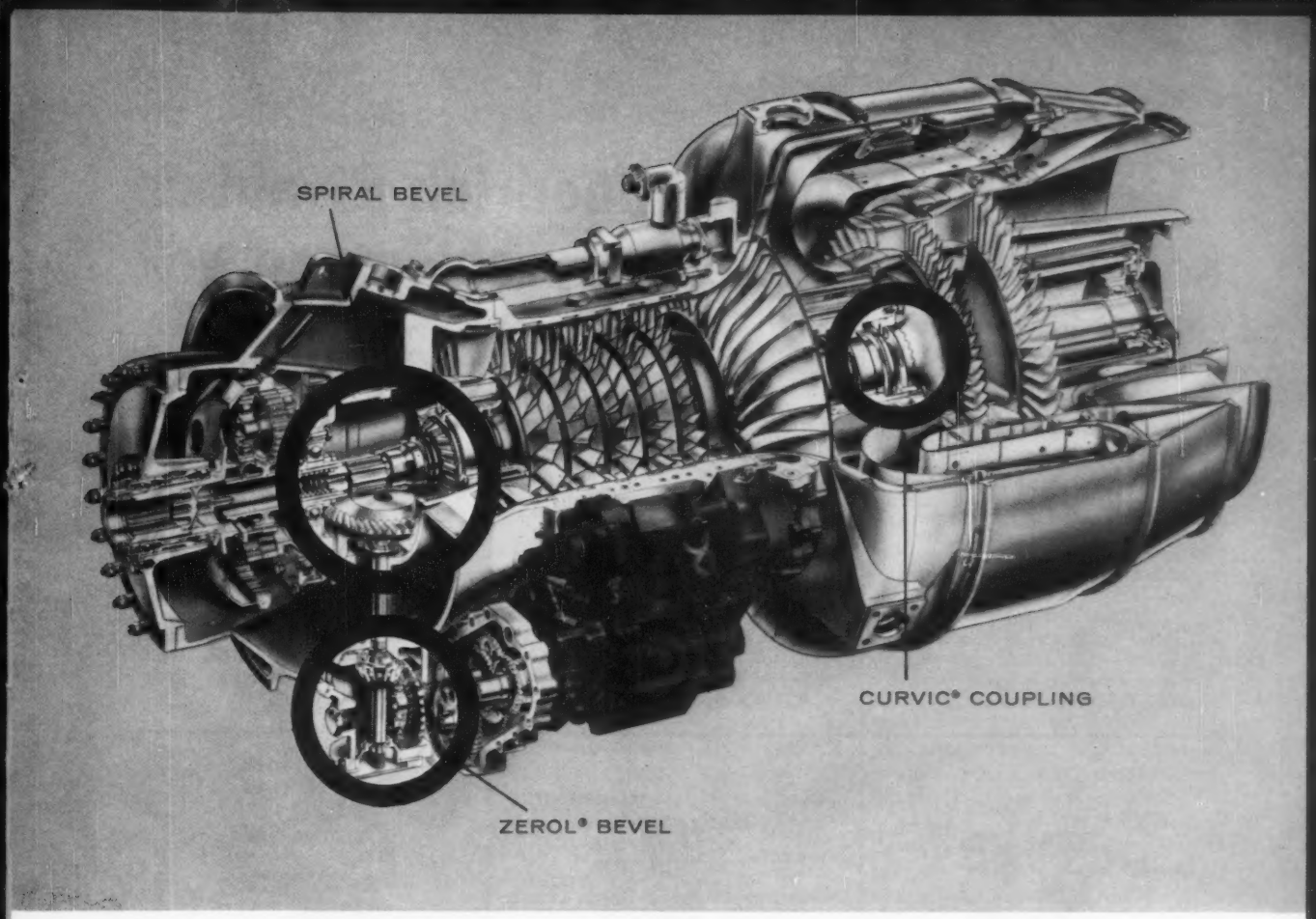
Both types shown are less expensive to manufacture than their ferrite counterparts; both serve combined functions, reducing the number of necessary computer components. They also require less current to operate than standard models, are relatively simple to install, and can be of any convenient length, depending on the number of bits per rod desired to be stored.

Bell Telephone Laboratories, New York, offers a reversible diodeless shift register employing 0.002 in. permalloy memory wire. The wire is stretched and twisted through a ceramic tube, on which are wound 0.075 in. long solenoids which serve variously as inputs, advance coils,

(*Please turn to Page* 31)



Bidirectional shift register, using currents from 140 to 240 ma, is easily manufactured and installed. Upper frequency limit is estimated by developer, Bell Telephone Laboratories, to be several hundred kilocycles.



How to get *engineering assistance* on gears and couplings like these

Gleason engineers are always ready to help you work out any problems involving bevel gears and couplings.

Such assistance came to the makers of this turbine in four different areas:

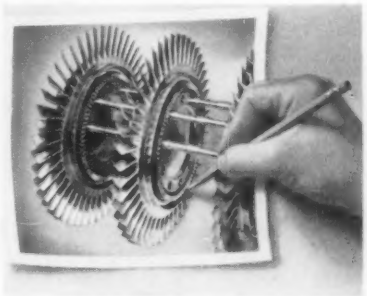
First, they naturally wanted components which met the designated theoretical requirements of the turbine. Our engineers helped determine the types and sizes of the gears and Curvic® coupling as well as such details as axial thrust and radial load.

Second, they wanted compactness. The angular drives made possible by the spiral bevel and Zerol® bevel systems helped materially to fit the drive into the limitations set by the turbine's over-all dimensions.

Third, they wanted low costs. The machines and methods developed by Gleason engineers assure the lowest possible costs for both gears and couplings whether made in small or large quantities. The Curvic coupling design inherently cuts coupling costs; see picture at right.

Fourth, the makers wanted extreme reliability. The success of the gears and couplings in this respect is witnessed by the fact that this turbine is used by six major aircraft companies and has recorded more hours of flying time than any other turbine in its power class.

If you would like to discuss your bevel gear or coupling application with a Gleason representative, please contact us.



With Curvic couplings complex machine parts can be made in several small units, reducing machining time, simplifying final assembly, and cutting over-all manufacturing costs.

GLEASON WORKS

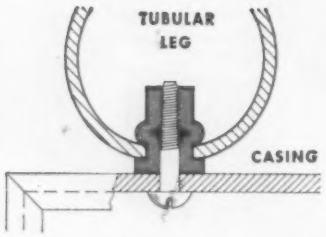
Builders of bevel gear machinery for over 90 years

1000 UNIVERSITY AVE., ROCHESTER 3, N. Y.

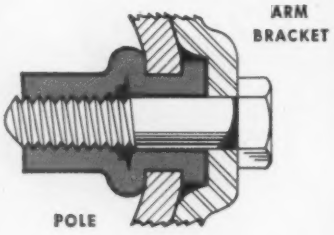
Circle 415 on Page 19

B.F.Goodrich

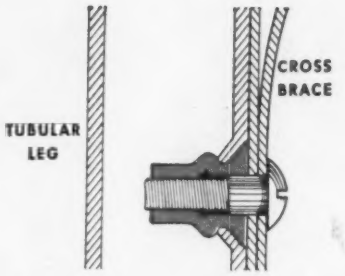
Only B.F.Goodrich Rivnuts® solve all these fastening problems so well



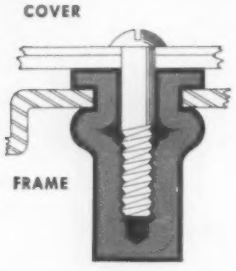
One man installs Rivnuts from one side in seconds—speeds assembly of *barbecues*. Permanent nutplates in legs save time in faster knockdown, too.



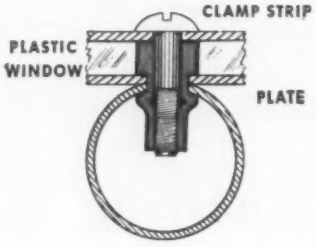
One man does the work of two, assembling arm brackets on *light poles*. Tests show pole or arm will fail before Rivnuts.



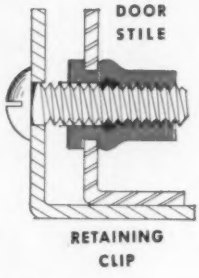
Clean, functional lines of modern *furniture* are preserved by Rivnuts. Upset inside tubular legs, they replace unsightly nuts, bolts and screws.



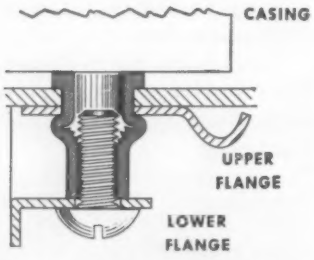
Rivnuts enable repair men to remove top of *automatic washer* and replace it easily. And Rivnuts can be installed after enamelling.



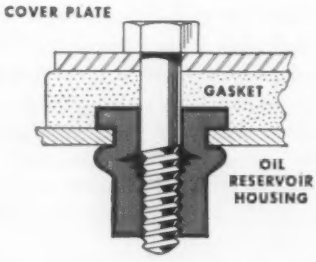
Upset Rivnuts secure *airplane window* plate to center post. Bulges in shanks seal out weather. Heads of Rivnuts serve as spacers for plastic window.



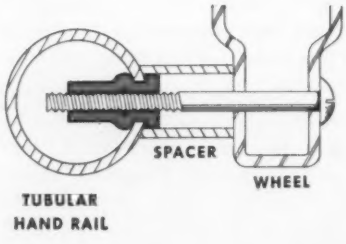
Rivnuts replace self-tapping screws used to hold retaining clips on aluminum *storm doors*, provide firm nutplates that won't loosen with shock or vibration.



Rivnuts eliminate need for reinforcing plates in *vaporizers*. In addition, Rivnuts space bottom flange automatically, prevent bending.



Assembly time for *oil reservoirs* is cut in half. Rivnuts eliminate welding, tapping and cleaning previously required to attach coverplate.



Wheel chair designers needed a blind nutplate with at least 6 clean threads. Rivnuts, only one-piece blind rivets with threads, were the answer.

Special fastening problems? B.F.Goodrich Rivnuts solve them. Send for free demonstrator. Dept. MD-128, B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Company, Akron, Ohio.

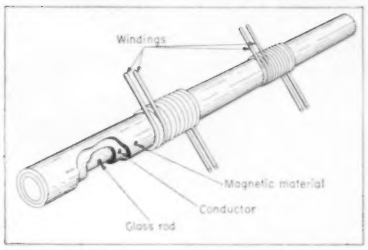
B.F.Goodrich ***aviation products***

Circle 416 on Page 19

(Continued from Page 28)

or readout.

Bits, "written in" by pulsing three coils at one end, are moved along the rod in sequence by proper pulsing of pairs of coils. Readout is accomplished by noting a response on the memory wire when readout coils are pulsed. The twist in the wire controls interaction between magnetic stations.



"Thinking" memory rod functions as storage cell, shift register, or logic switching component. It works either in coincident current or word-ordered applications and will increase computer processing speed 10 to 20 times, says National Cash Register Co.

In the second type storage unit, a 0.015 in. diam glass rod, to which is added a magnetic coating, is the base on which up to four sets of solenoid-type coils are wound in layers. This development was announced by National Cash Register Co.'s Electronics Div., Hawthorne, Calif. Ability to operate at temperatures in excess of 200 C and down to −100 C, combined with extreme speed and versatility, suggest its use in missile and satellite control systems where its low power requirements would increase the range of the vehicle.

Packing density is now about 1000 bits per cubic inch. Logical switching can be performed at a rate of 5 megacycles without adverse heating. Using an inhibit logic system, one 3-in. rod handles as many as 30 different propositions. As a high-speed memory it cycles in 1 microsecond. As a shift register or counter, it can operate at a 5-megacycle frequency.

Missile Instruments Survive 40,000-g Splash

Radio Transmitter Talks After High Dive From Space to Ocean

Potted in plastic spheres, instruments carried through space in nose cones of Thor and Atlas missiles are being recovered from the ocean in operating condition after the spheres impact without benefit of parachutes. One sphere, recovered last month by fishermen, had been adrift for more than 2 months. Information on its recording tape was still intact and scientifically useful.

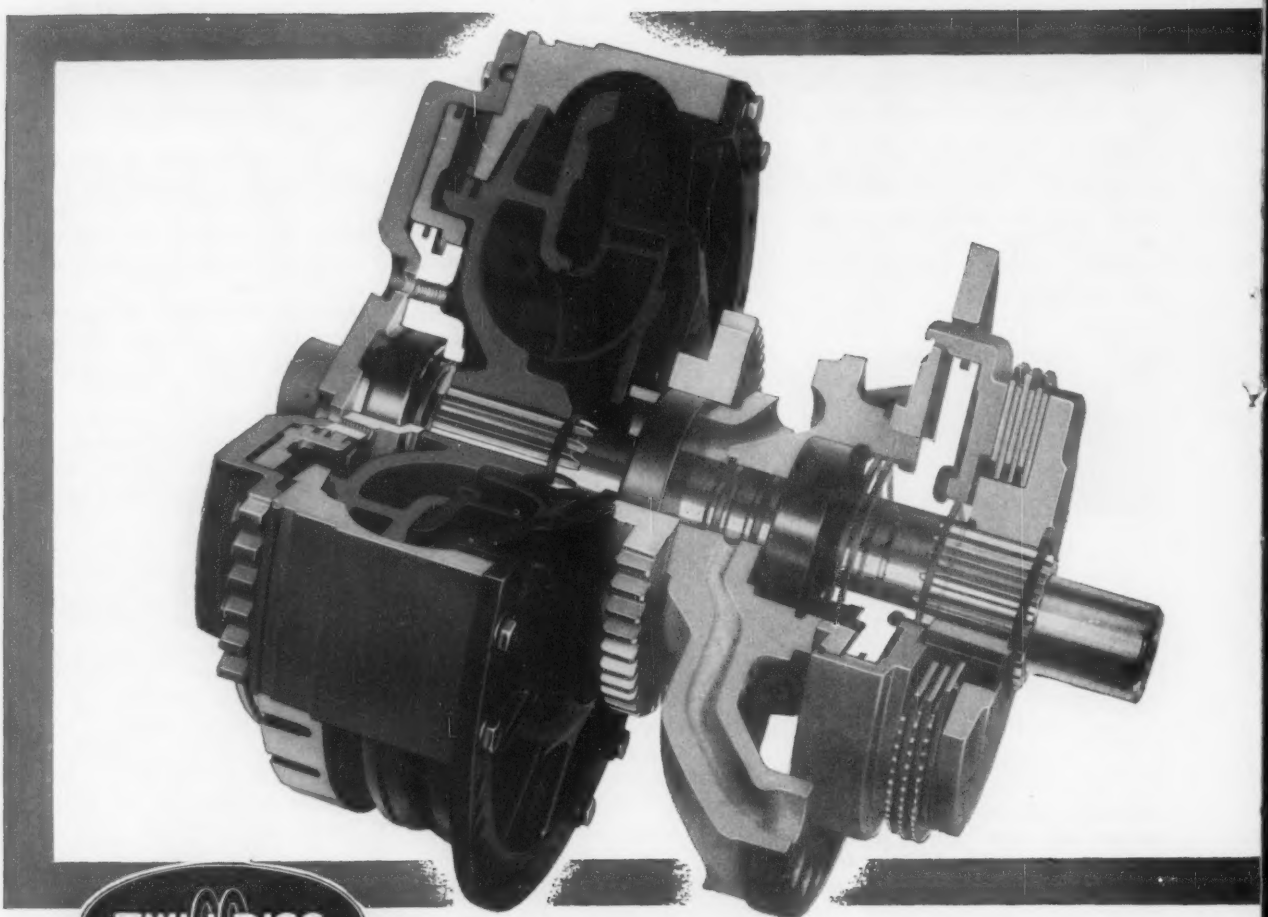
Purpose of the data capsule is to provide scientists with knowledge of nose-cone performance. Although most missile re-entry information can be telemetered to receiving stations in a conventional manner, a blackout occurs when the nose cone reaches peak speeds. Air in front of the cone is ionized and interferes with radio transmission. Small, rugged tape recorders packed in the plastic capsules log all pertinent information concerning temperature, pressure, stress, acceleration, and deceleration.

The outside shell of the 18-in. diam capsule is urethane plastic foam covered with an ablative material. Instruments mounted inside are potted in urethane foam which enables them to withstand the tremendous 40,000-g force imposed on the sphere as it strikes the water.

As the capsule plummets downward, the ablative covering burns, protecting the instruments from heat. This covering shatters off at impact, and the plastic capsule bobs to the surface. Three recovery devices, activated by a salt-water switch, then begin notifying search parties of the capsule's location: A sonar bomb is ejected and explodes at a preset depth for detection by underwater-listening devices; a special die is released to permit visual search; and a tiny, rugged radio beacon begins broadcasting.

General Electric's Missile and Space Vehicle Dept. built the data capsule for research on Thor and Atlas nose cones.

Lower half of the data capsule (left) is equipped with a tape recorder (bottom), junction box (rear), battery pack (front), dye markers (two at left), and sonar bomb (cylinder right). At left is the connector which feeds information from the nose-cone sensors to the tape recorder. Also visible is an opening in the lower hemisphere for exposure of a salt-water switch. The entire sealed capsule is placed in a container with a JATO unit (rear). This basket-like container, with the capsule held in place by releasable metal straps, is installed in the nose cone with the sphere facing rearward. At a predetermined point before impact, the JATO-unit fires, throwing the capsule free from the cone.



New Single-Stage Stripped Torque Converter

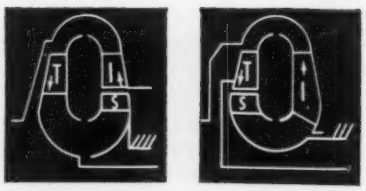
Efficiency, adaptability, long life — all in one low-cost package — that's the new Twin Disc 1100 Series Torque Converter. It's furnished as a "stripped" unit to be designed into any drive line of appropriate capacity. Wherever mild torque conversion is desired — shovels, cranes, tractors, materials handling equipment — this new unit provides compactness and low cost without sacrificing heavy duty construction.

The 1100 Series is rated for engines producing up to 188 hp at 3700 rpm and up to 265 lb.-ft. of torque. Five torque ratings permit close matching of converter to engine for maximum efficiency and fuel economy.

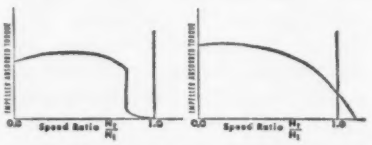
Other torque converter advantages: Cushions out shocks and vibrations . . . eliminates lugging and stalling . . . automatically matches power to load demands . . . permits delicate holding and inching under power . . . minimizes gear shifting.

Considerable design latitude is provided by two optional circuit designs (see torque characteristics at right).

This new "stripped" single-stage converter enables original equipment manufacturers to offer the sales appeal of torque converter drives at the lowest possible cost. For single-stage units with higher capacities, Twin Disc also offers the 1300 and 1500 Series Torque Converters.

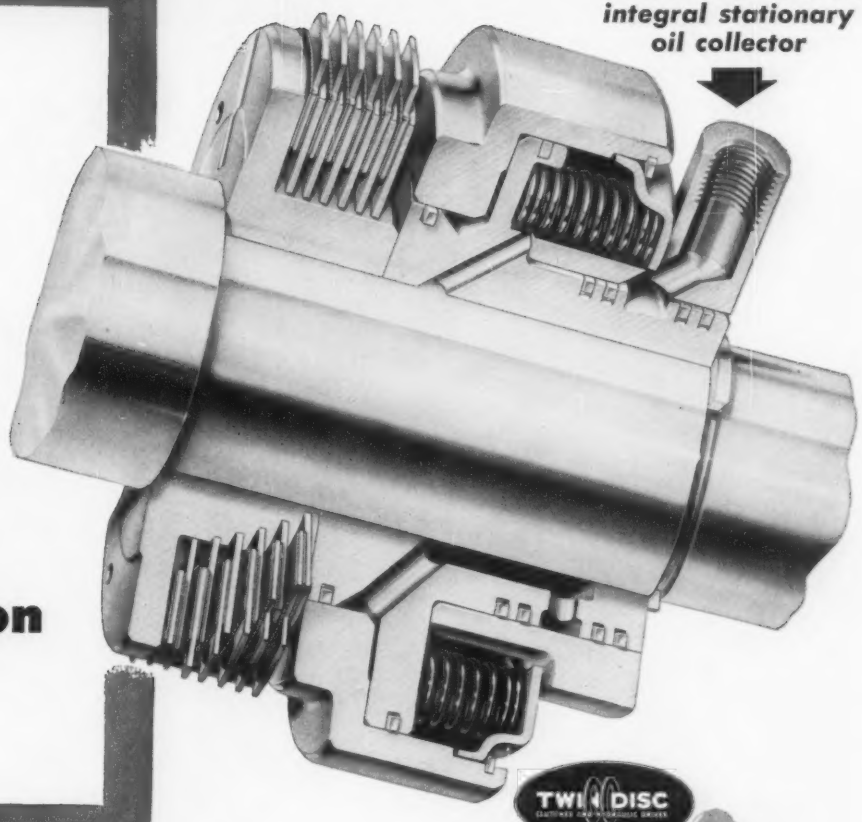


Schematic drawings of the two types of single-stage circuits. The Type 1 (outflow) circuit is at left. Type 6 (inflow) is at right.



A comparison of the torque characteristics of the Type 1 circuit (left) and the Type 6 circuit. The Type 1 circuit unloads the engine quite abruptly at a speed ratio of about .825. The Type 6 design allows a no-load speed ratio of 1.15:1.

Design either or both of these new units into your transmission



TWIN DISC

Friction Clutches and Fluid Drives

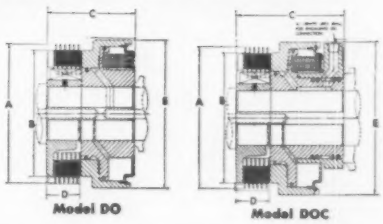
New Oil-Actuated Multiple-Plate Clutches

Clutch failures and burn-outs are virtually eliminated in these new wet-type Twin Disc Clutches. No adjustments are needed because ram travel compensates *automatically* for plate wear.

Designed for machine tools and similar applications, these units are built to run in oil and are actuated by oil pressure of 100 to 300 psi. Model DOC (shown above) has an around-the-shaft oil collector connected by a 1/4" line. Model DO is identical except that the oil collector is omitted, shortening the clutch somewhat.

Compact design, smooth performance, long wear—with no adjustment problems—these benefits are available *now* in Twin Disc Oil-Actuated Multiple-Plate Clutches. Write for full details.

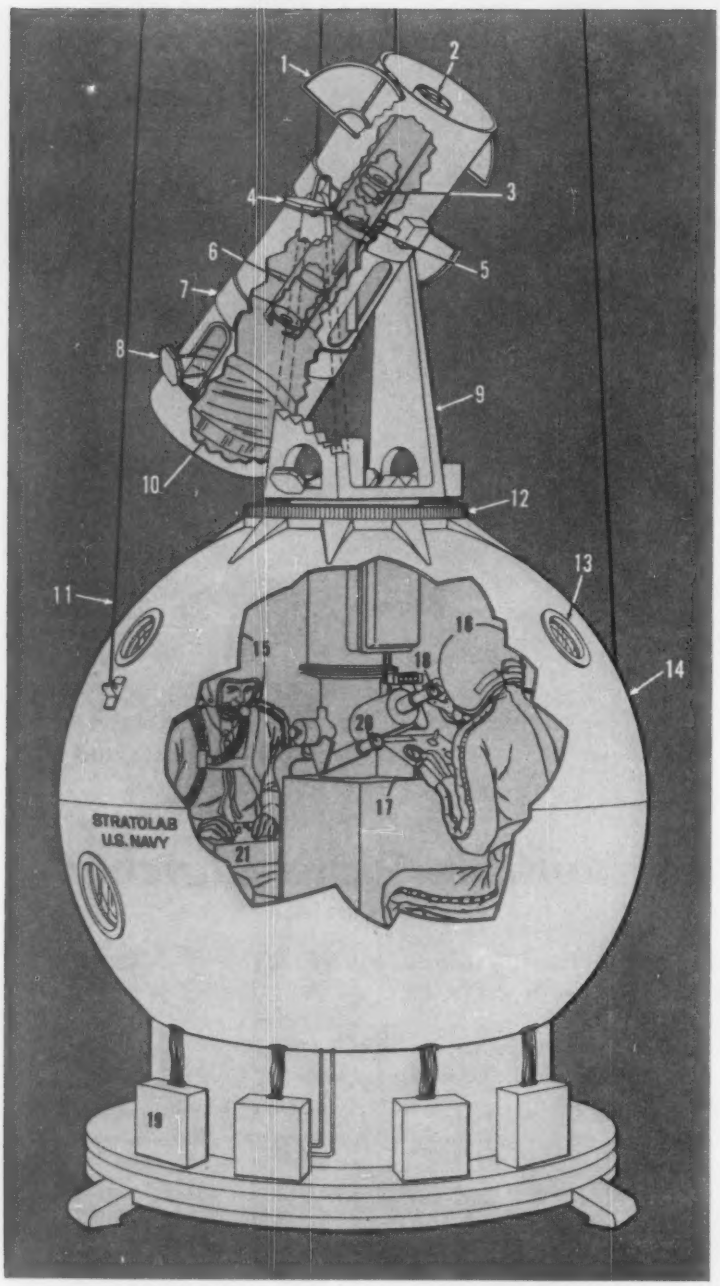
Twin Disc Clutch Company, Racine, Wisconsin. Hydraulic Division, Rockford, Illinois.



Model No.	Torque Capacity Lb.-ft.	Hp Capacity	Max. Allowable Rpm		A	B	C (length)	D	E
			With Hydraulic Balance	Without Hydraulic Balance					
DO-403	37	9	5000	2700	3.31	3.00	2.583—2.566	1.02	3.60
DOC-403			5000	3480			3.509—3.486		
DO-403½	95	20	5000	2680	3.81	3.50	2.992—2.972	1.17	4.42
DOC-403½			5000	3500			3.789—3.766		
DO-604	130	31	5000	2670	4.38	4.00	3.255—3.241	1.26	4.80
DOC-604			5000	3660			4.160—4.142		
DO-605	330	58	4500	2270	5.50	5.00	3.447—3.419	1.35	5.90
DOC-605			4500	3070			4.267—4.239		
DO-706	435	100	3750	1815	6.56	6.00	3.981—3.963	1.60	6.90
DOC-706			3750	2560			4.922—4.904		
DO-707	690	137	3250	1790	7.62	7.00	4.697—4.679	2.12	8.00
DOC-707			3250	2550			5.540—5.522		

Circle 417 on Page 19

Eye in the Sky



1. Sun filter
2. Cassegrain telescope
3. Image sensor
4. Acquisition mirror No. 2
5. Monocenter mirror
6. Relay telescope
7. Schmidt telescope
8. Acquisition mirror No. 1
9. Mount
10. Schmidt 16-in. mirror
11. Gondola shrouds
12. Azimuth drive
13. Observation port
14. Gondola
15. Balloonist
16. Astrophysicist
17. Control panel
18. Target eyepiece
19. Batteries
20. Acquisition eyepiece
21. Coarse control panel

FIFTEEN MILES straight up from Rapid City, S.D., a pair of scientist-balloonists, cramped into a 7-ft spherical "observatory," are looking for water on Mars. Conditions for the spectrographic search are good. Riding at 80,000 ft, comfortably above Earth's turbulence and dust, the 16-in. Schmidt reflector on top of the gondola can outperform even the 200-in. giant on Mt. Palomar. For the first time, an infrared record of Mars' atmosphere will be written spectrographically in the high-flying Stratolab without interference.

Dr. John Strong—Johns Hopkins' astrophysicist, balloonist, and world-renowned authority on infrared rays—recognized a potential design problem even before the first ascent. The smallest movement of men or equipment threatened to set up a torsion-pendulum reaction in the gondola, making it impossible to hold Mars in the telescope's field.

The unique solution: A telescope-within-a-telescope called Star Tracker by its designer, Librascope Inc., Glendale, Calif. Despite movements of the gondola, this device locks firmly on Mars and holds its image steady on a narrow spectrometer slit during a three-hour analysis period.

The Star Tracker assembly—originally the concept of Dr. Strong—requires only that the Schmidt tele-

Sealed in their aluminum "observatory" for a 24-hr flight, Dr. John Strong, astrophysicist, and Comdr. Malcom Ross, pilot, begin spectrographic study of Mars. First step is aiming the 16-in. Schmidt in azimuth and elevation with the acquisition scope. Despite the inevitable twisting of the gondola, dangling on its 200-ft nylon shrouds, the Star Tracker telescope tracks and holds the image of Mars to an accuracy of 1 sec of arc.

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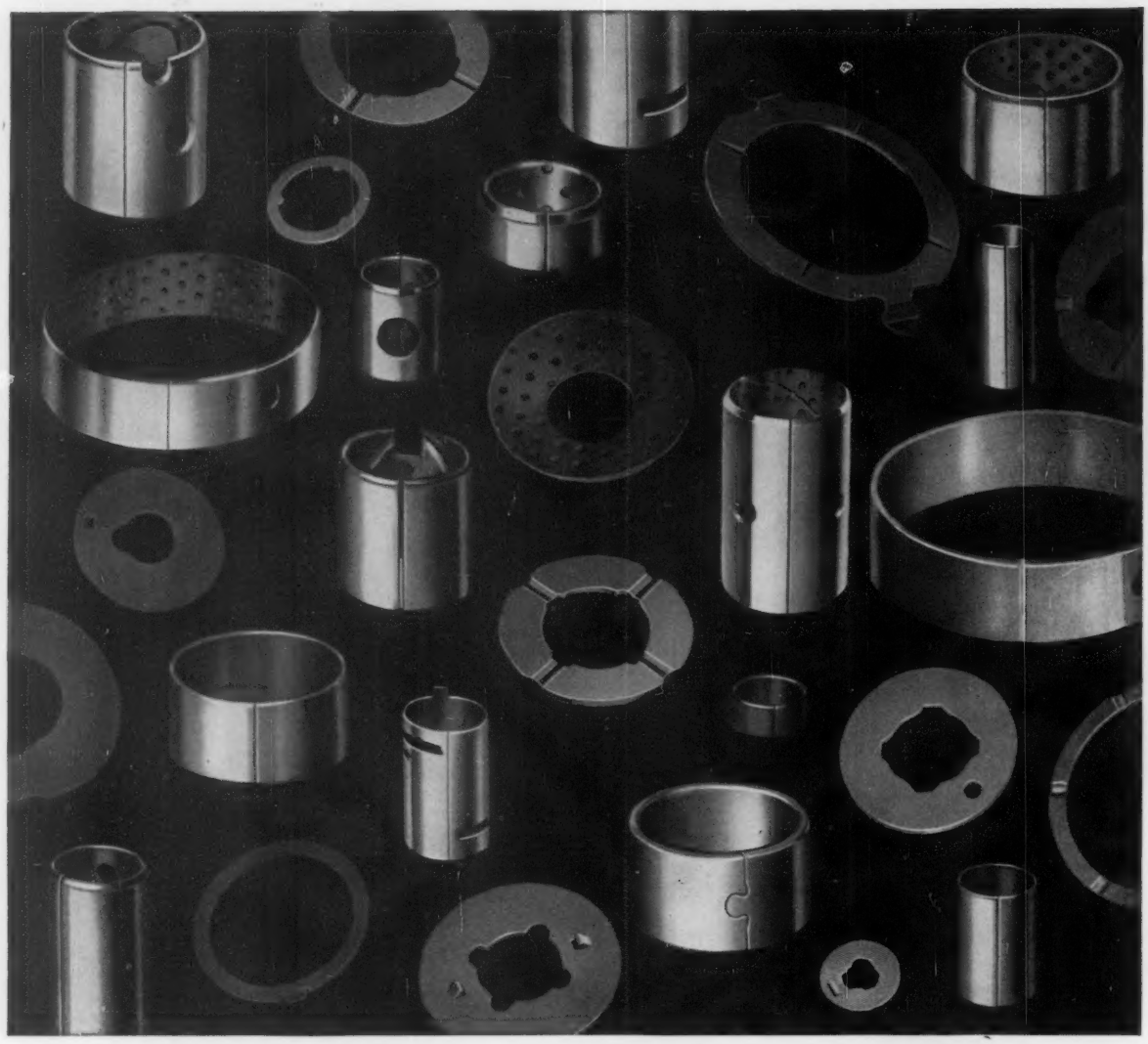

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Precision thrust washers of solid bronze, or steel with bronze on one or both faces, may be flat, spherical or special shapes, with grooves, holes, nibs, lugs or scallops. Cold-rolled for exceptional hardness in heavy-duty use. 1″ to 6″ O.D.

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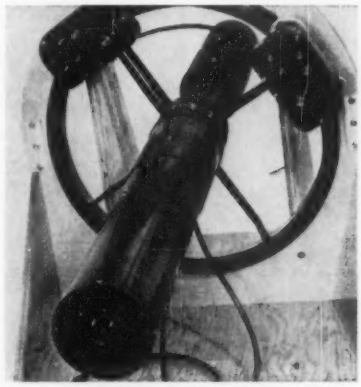
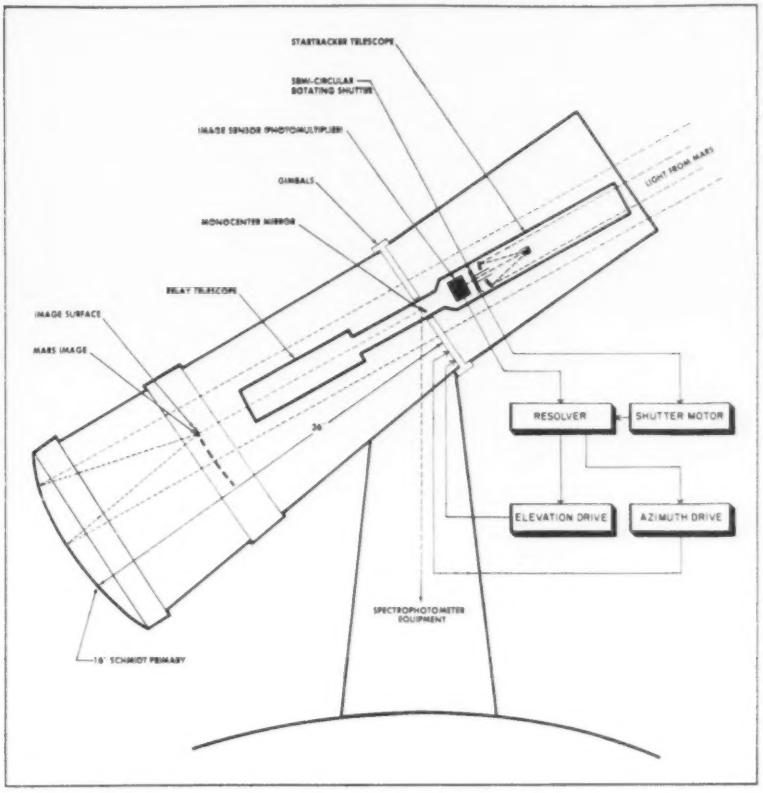
scope be occasionally adjusted by the observer to maintain Mars within its 3-deg field of view. A servo-controlled 3-in. Cassegrain telescope, looking out from the forward end of the Schmidt, swivels slowly to hold its light-gathering barrel accurately aimed at Mars.

Positioned in the auxiliary Cassegrain scope and coincident with the Schmidt monocenter (center of curvature of 16-in. mirror and image "surface"), a flat relay mirror transfers Mars' image to the spectrometer. As long as the tracker remains locked on Mars, the relayed image remains accurately centered on the spectrometer slit.

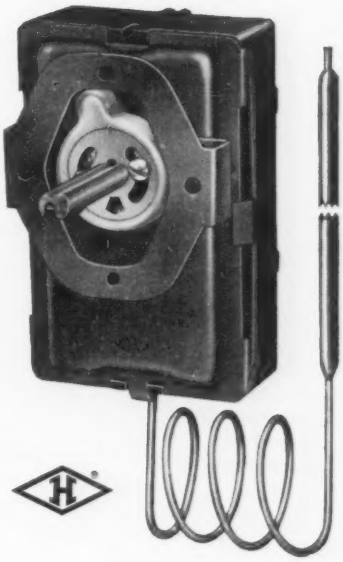
Until the flight of the Star Tracker, astronomers' studies of the gases on Mars contained an element of uncertainty. No one knew exactly how much information was cancelled out by passage of light through the murky atmosphere of Earth. High in the cold clarity of the stratosphere, Star Tracker's eye will give its spectrographic answer.



Star Tracker,, in temporary frame, awaits mounting in Schmidt barrel.



Key to operation of Star Tracker is the curved "image surface" of the Schmidt 16-in. spherical mirror. A servo-controlled relay telescope, looking back at the image of Mars, swivels a tiny flat mirror at the system monocenter (center of curvature of both Schmidt mirror and image surface). Swiveling of the monocenter mirror holds the image of Mars accurately centered on a 0.5-mm spectrometer slit. The sensor that keeps Star Tracker's barrel aligned with light rays from Mars is a rotating semicircular shutter which modulates incident light falling on a photomultiplier tube. When the image of Mars, formed by the Cassegrain optics, is not directly centered on the shutters, the light beam is interrupted. The alternating-voltage signal then actuates the servo to realign Star Tracker with Mars.



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For range ovens, appliances, motor or solenoid control, restaurant and laboratory equipment, industrial and air conditioning applications.

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Circle 420 on Page 19
Circle 421 on Page 19→

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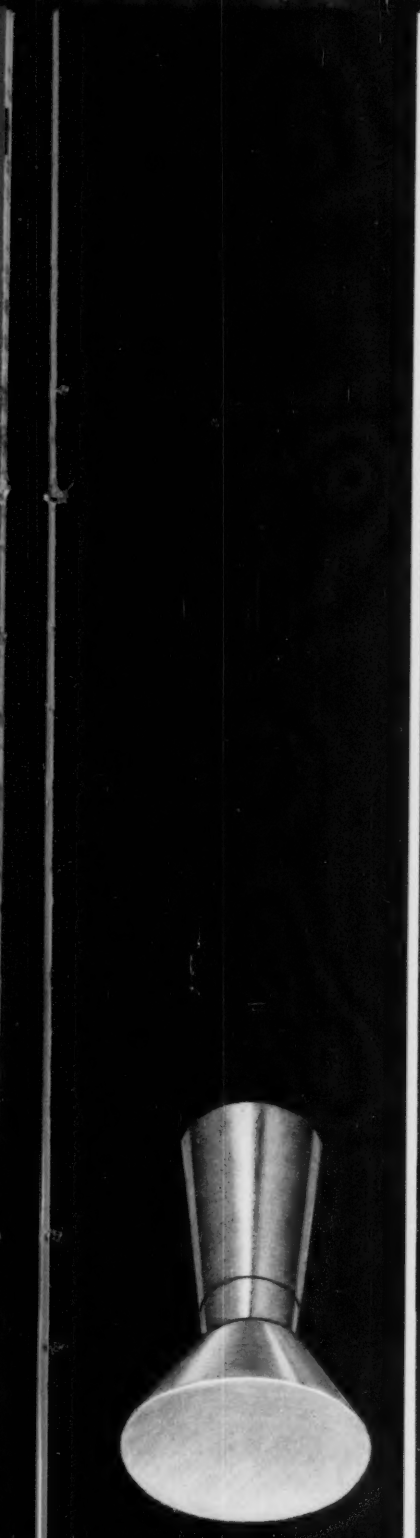

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If you would like design details for the parts shown here, complete with cost and production data, please send in the coupon below.

(Kaiser Aluminum does not manufacture screw machine parts, but does offer technical assistance to parts suppliers throughout the country. Contact your local screw machine products manufacturer for further information and quotations on specific parts in aluminum.)

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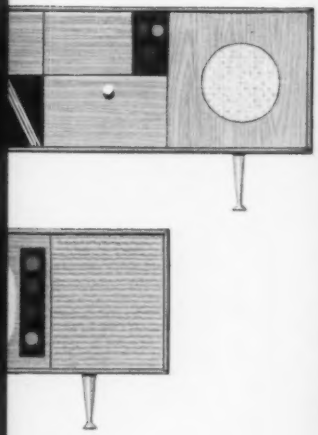

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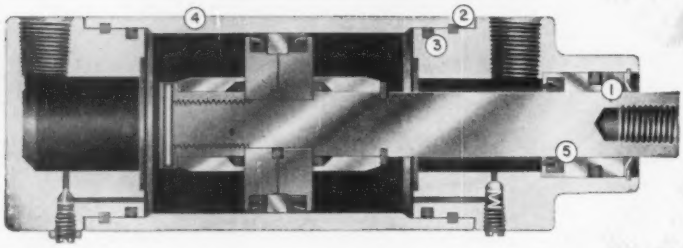

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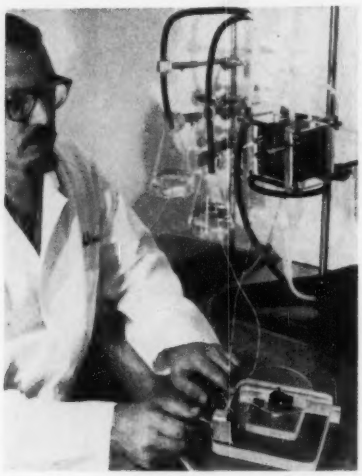


Laboratory model of Lockheed's fuel cell powers a small electric motor.

Electric Cars May Come Back Says Fuel-Cell Researcher

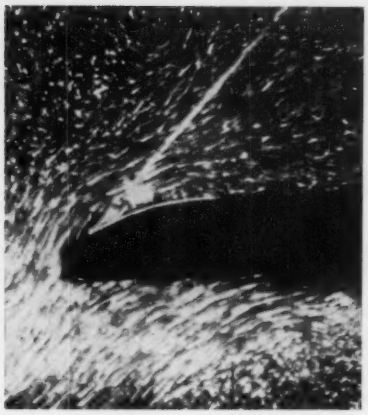
Powerful DC Package Ready in Five Years

BURBANK, CALIF.—A fuel-cell that will yield sufficient energy for powering automobiles or aircraft can be developed within 5 years, according to Lockheed scientist, Dr. Morris Eisenberg. An 80-watt-hour-per-lb cell would excite automotive engineers, says Dr. Eisenberg, and Lockheed is presently developing a cell that will produce 100 whr per lb. Automobile storage batteries yield between 8 and 10 whr per lb.

Eisenberg's 5-year prediction also includes development of a 300-whr-per-lb cell which would provide a handy power source for electrification of rural areas, remote radar and communications stations, and operation of industrial machinery.

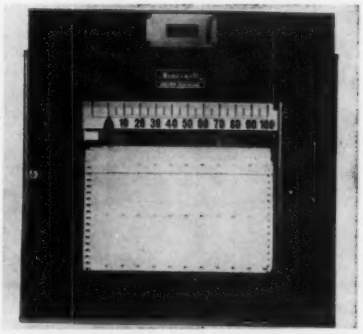
Fuel cells produce electricity—and water—by the interaction of oxygen and hydrogen gases. The cell's anode and cathode are merely catalysts to the action and are not consumed in the process, as are the electrode materials in a conventional storage battery. Energy-conversion efficiency is better than 70 per cent.

Lack of a simple method of supplying oxygen and hydrogen has been the greatest obstacle to the use of fuel cells to date. The method being investigated by Lockheed is not disclosed, but is presumably the key to current enthusiasm.



Tunnel Substitutes Water for Air

Three-dimensional detail of flow around fixed or rotating surfaces is shown for the first time by this unusual water tunnel. Where in wind tunnels there is no satisfactory way to locate turbulence around closely spaced objects, turbulence in the water tunnel can be focused sharply by introduction of air bubbles, oil droplets, or even bits of plastic, say developers. Another advantage noted is that the denser water need move at only one-thirtieth the speed of air to produce equivalent conditions. The tunnel is used by Westinghouse Electric Corp., Pittsburgh, to perfect designs for steam turbines, ventilating fans, and other rotating equipment.

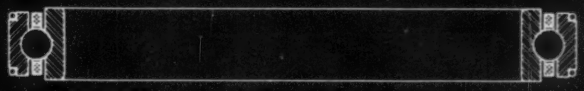


Recorder Plots, Integrates Data

Continuous integration of a rapidly fluctuating function is read out on a six-place digital counter in a new strip-chart recorder designed by Brown Instruments Division, Minneapolis-Honeywell Regulator Co., Philadelphia. An alternate dual-pen arrangement gives both the analog record of the fluctuating signal and its time integral. With an accuracy of ±1.0 per cent, the recorder can be used to measure flow, power consumption and in continuous weighing systems.

NEW thin-section T series instrument bearings

Made in two precision grades to AFBMA dimensions for B-500 Series.



Type TCR — For high speeds and combination radial and thrust loads with low torque values. Furnished with maximum ball complement in a strong, light, precision-machined, **one-piece retainer.** Where even lower torque values are required, and loads may be reduced, Type TCR is available with fewer balls on special order.

Type TCF — For maximum radial load capacity and high thrust load capacity from either direction. **Full ball complement without filling notch.** Open construction for applications where relubrication is desirable.

Type TCA — Same as TCF except alternate balls are undersize for much lower torque characteristics, as in TWA type. For use where dirt conditions are not severe, or where closures exclude dirt.

Type TWF — **Integral shields** protect against dirt with seal advantage yet no seal friction or ring distortion caused by inserting separate shields. No loading notch, yet full ball complement for maximum radial and thrust loads.

Type TWA — Same as TWF except alternate undersized balls are used as idlers between load carrying balls for smooth-running low torque characteristics.

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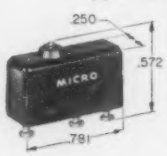
Circle 423 on Page 19

MICRO SWITCH Precision

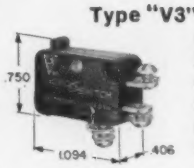
Here's why you are most likely to find the right switch for your needs at MICRO SWITCH

Type "SM" basic switches—259 variations



Subminiature in size, yet feature precision operation, long life, and high electrical capacity—up to 5 amps., 125 or 250 vac. Catalog 75 gives detailed information on "SM" subminiature switches, including actuators, housings, and assemblies.

Type "V3" basic switches—198 variations

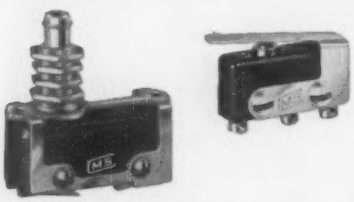


Combine extra compactness with high electrical capacity—up to 10 amps., 125 or 250 vac.—long life, and precise operation. Catalog 74 gives detailed information on "V3" switches and actuators.

The 259 variations are used in the following:			The 198 variations are used in the following:		
112 AUXILIARY ACTUATORS	**153** TOGGLE ASSEMBLIES	**42** ROTARY SELECTOR ASSEMBLIES	**88** AUXILIARY ACTUATORS	**71** TOGGLE ASSEMBLIES	**64** ROTARY SELECTOR ASSEMBLIES
129 METAL ENCLOSURES	**256** PUSHBUTTON ASSEMBLIES	**42** ALL OTHER ASSEMBLIES	**75** METAL ENCLOSURES	**3** PUSHBUTTON ASSEMBLIES	**77** ALL OTHER ASSEMBLIES

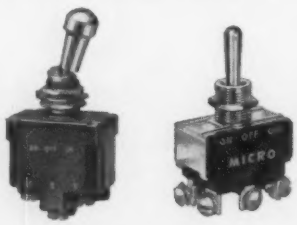
AUXILIARY ACTUATORS

Auxiliary actuators are used with basic switches, singly or in groups, to produce actuation from almost any direction or amount of force. Two examples are shown.



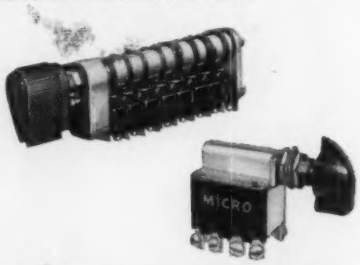
TOGGLE ASSEMBLIES

Many kinds of toggle switch actions are provided by a wide variety of toggle assemblies. Here are two examples.



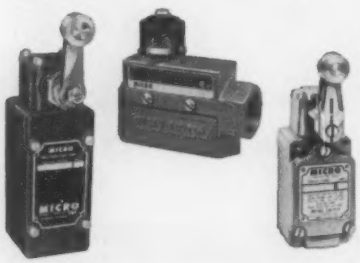
ROTARY SELECTOR ASSEMBLIES

Precise sequential actuation of multiple-switch assemblies is provided by rotary selector assemblies like these.



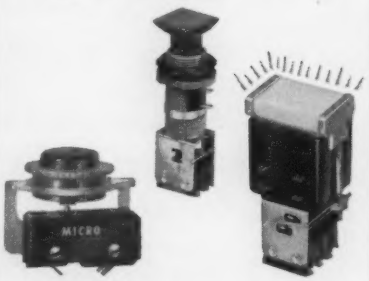
METAL ENCLOSURES

Metal enclosures provide protection from physical damage, sealing against harmful environments, means of mounting and conduit connections. Three examples are shown.



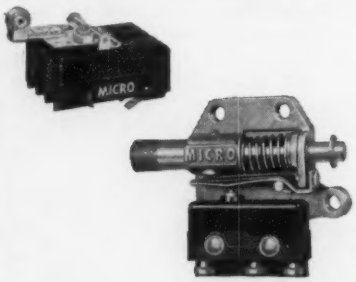
PUSHBUTTON ASSEMBLIES

Lighted pushbuttons, colored buttons, and assemblies for multiple switch operation are available for panel mounting. Here are three examples.



OTHER ASSEMBLIES

Other assemblies include door interlocks with automatic reset feature to assure safety, and single actuated dual mounted switch assemblies. Here are two examples.



Switches have uses unlimited

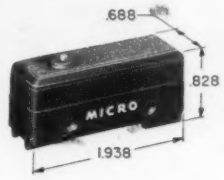
From just six of the basic switches in the MICRO SWITCH line come 7,577 different switches and assemblies . . . for use in machine tools, presses, machinery . . . computers, control panels, instruments . . . aircraft, missiles, launchers . . . to control and limit and guide almost everything in our modern electrical world.

The tabulation does not include our newest "baby"—the "SX"—shown here actual size.

Actual Size

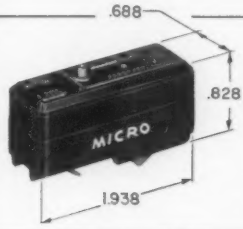
This is the first sub-subminiature, half the size of the famous "SM" subminiature, yet with 5 amp. capacity at 125 or 250 vac, long life and precision operation.

Nor does the tabulation include many basics for special applications, or mercury switches, of which there is a broad line.



Type "Z" basic switches—3,800 variations

Precise actuation and comparatively low operating force and motion. Up to 15 amps., 125, 250, 460 vac. Catalog 62.



Type "A" basic switches—950 variations

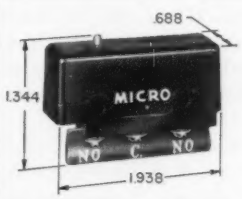
Extra-high electrical capacity — 20 amps. steady state current; 75 amps. inrush current—at up to 460 vac. Catalog 62.

The 3,800 variations are used in the following:

68 AUXILIARY ACTUATORS	**1** TOGGLE ASSEMBLIES	**—** ROTARY SELECTOR ASSEMBLIES
765 METAL ENCLOSURES	**16** PUSHBUTTON ASSEMBLIES	**14** ALL OTHER ASSEMBLIES

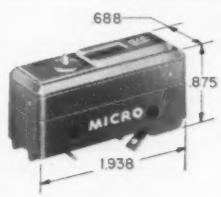
The 950 variations are used in the following:

27 AUXILIARY ACTUATORS	**—** TOGGLE ASSEMBLIES	**—** ROTARY SELECTOR ASSEMBLIES
58 METAL ENCLOSURES	**14** PUSHBUTTON ASSEMBLIES	**16** ALL OTHER ASSEMBLIES



Type "DT" basic switches—78 variations

Highly compact double-pole double-throw switches, with marked terminals providing normally-open and normally-closed contact for each pole. 10 amps., 125 or 250 vac. Catalog 62.



Type "MT" basic switches—67 variations

Long life, high d-c capacity switches—10 amps., 125 vdc—when wired either "polarized" or "non-polarized". SPDT. Offer compact units for flexible control of motors, solenoids, etc. Catalog 62.

The 78 variations are used in the following:

29 AUXILIARY ACTUATORS	**1** TOGGLE ASSEMBLIES	**—** ROTARY SELECTOR ASSEMBLIES
62 METAL ENCLOSURES	**8** PUSHBUTTON ASSEMBLIES	**6** ALL OTHER ASSEMBLIES

The 67 variations are used in the following:

7 AUXILIARY ACTUATORS	**1** TOGGLE ASSEMBLIES	**—** ROTARY SELECTOR ASSEMBLIES
11 METAL ENCLOSURES	**8** PUSHBUTTON ASSEMBLIES	**1** ALL OTHER ASSEMBLIES

Experienced engineering assistance in switch application in your field is available from the MICRO SWITCH branch office near you. Consult the Yellow Pages. For the right switch—and every switch right—look first to MICRO SWITCH.

MICRO SWITCH . . . FREEPORT, ILLINOIS
A division of Honeywell
In Canada: Honeywell Controls, Ltd. • Toronto 17, Ontario

Honeywell
MICRO SWITCH PRECISION SWITCHES

Circle 424 on Page 19

PUMP DESIGN TRENDS

by Arthur A. Nichols

NEW INSERT PACKAGE REDUCES PUMP COSTS

Fig. 1. Three Gerotor components permit pump to be incorporated as integral part of housing or frame of mechanism, eliminate need for purchase and mounting of separate, complete pump.

It's no longer necessary to buy complete pumps for handling fluids at pressures up to 1,000 psi. Now . . . for a fraction of the cost . . . you can design three simple components integrally into your mechanisms and get equal or better performance.

Three matched components are all you need buy. *(Fig. 1.)* Consisting of an inner and outer Gerotor and an eccentric locator-ring, the unit becomes a complete pump by simply boring the casting or frame of the mechanism to accommodate the eccentric ring O.D. and by providing porting. This design makes the main casting do double duty as the pump housing, thus eliminating a very considerable cost factor. A drive can be taken from any convenient shaft. *(Fig. 2.)*

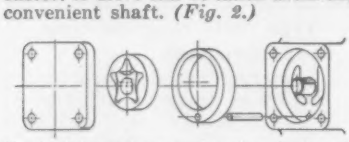


Fig. 2. Nichols integral pump-package is as easily installed as an anti-friction bearing.

Your built-in pump will give you all the advantages that make Nichols positive-displacement Gerotor pumps first choice for numerous applications: It is lightweight, valveless, self-priming, long-wearing, balanced and extremely quiet. In addition, it has high mechanical and volumetric efficiency.

Gerotor Insert-Packages can be designed and mass-produced to deliver up to 100 gpm and 1,000 psi within a wide range of mechanism geometry. That's because Gerotor pump capacity is a function of diameter, thickness, number of teeth and rpm of the two moving parts. These variables can be matched to just about any space restriction and capacity requirement.

Investigate this cost saving development. Just send us information about the fluid you want to handle, rate of flow, pressure and dimensional limits. We'll provide specific recommendations, estimated costs and technical data.

W. H. NICHOLS CO.

38 Woerd Ave., Waltham 54, Mass.

Circle 425 on Page 19

Hear-See Tape Recorder

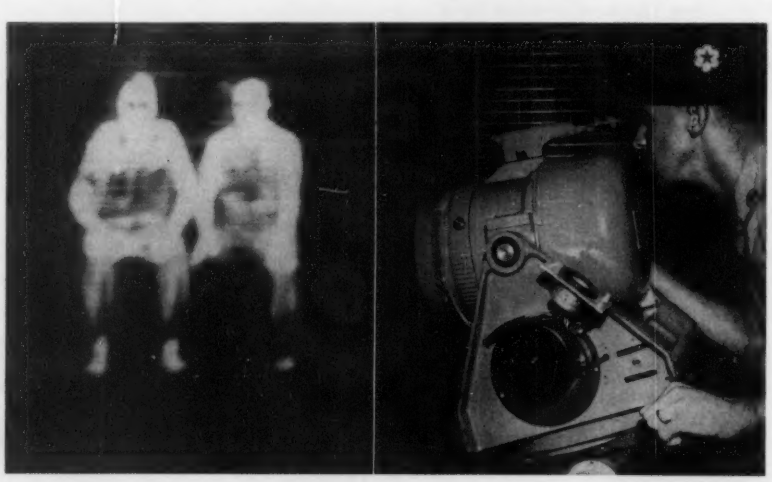
TV fans may soon be able to record their favorite programs for repeated showing. RCA has an experimental sound-picture tape recorder that works through standard black and white television sets. It uses a small transistorized camera and special magnetic tape. In addition to home-made recordings, the device can also accommodate prerecorded tapes—which may open a tremendous new market, according to RCA. The company has disclosed no marketing date.

Army's Thermal Camera Takes Pictures in Pitch Darkness

Prototype Shows Promise as Valuable Night-Fighting Aid

FT. BELVOIR, Va.—Any object with a temperature above absolute zero is theoretically photogenic with an experimental infrared camera being tested by the Army. While the prototype camera is not yet sensitive to temperatures quite that extreme, it takes clearly readable pictures of people, terrain, and buildings in total darkness.

With further development, the new device, called a Thermograph, is expected to be a valuable tool for



Two soldiers setting for an infrared portrait appear as ghost-like figures on the developed film. Man on right actually has one leg. Photograph was snapped in complete darkness with the Army's new Thermograph.

night reconnaisance, terrain mapping, target location, and camouflage detection.

In operation, infrared radiation is collected by an optical-scanning system and focused onto an infrared detector. The electrical signal caused by radiation aimed at the detector is compared to a preset reference level. Amplified deviations above the reference level modulate the light output of a glow tube. This forms a thermal image of the scene on photographic film in a Polaroid Land camera for quick development.

Grayness of each element in the thermal image is related to the apparent radiation of the background. Thermograph measures only apparent radiation, since the intervening atmosphere and the emissivity of the object may modify the actual radiation of the background. Resolution of the Thermograph is one milliradian by one milliradian.

Barnes Engineering Co., Stamford, Conn., developed the camera for Army Engineer R & D Laboratories.

Meetings

AND EXPOSITIONS

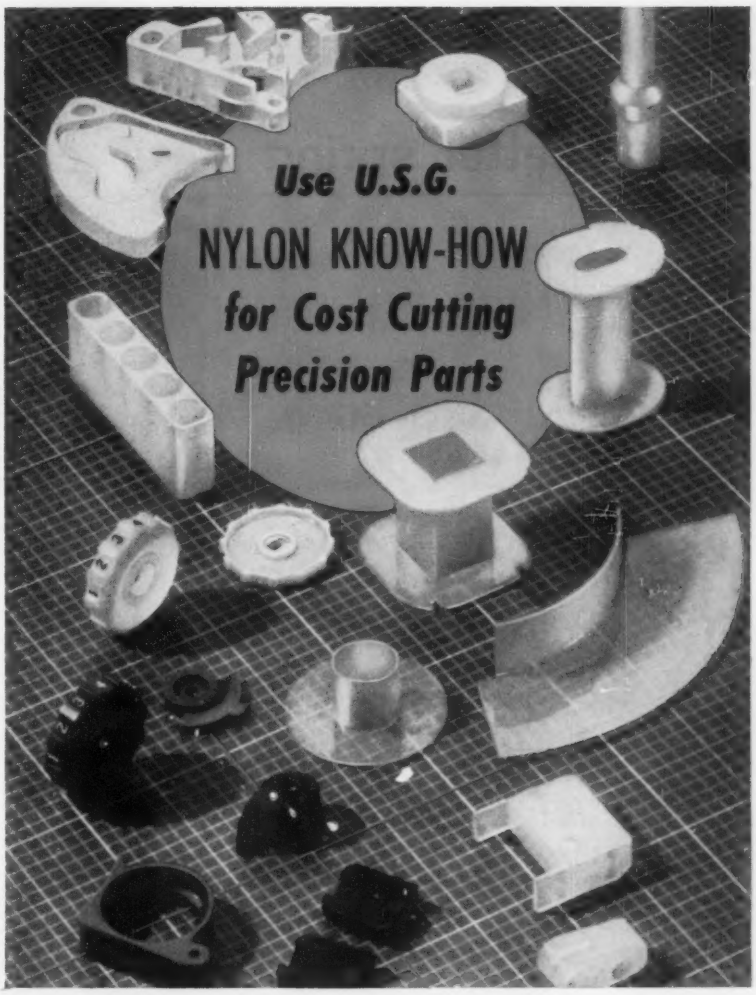
Jan. 12-14—

Fifth National Symposium on Reliability and Quality Control in Electronics to be held at the Bellevue-Stratford Hotel, Philadelphia. Sponsors are American Institute of Electrical Engineers, American Society for Quality Control, Electronic Industries Association, and Institute of Radio Engineers. Additional information can be obtained from E. K. Morse, Aeronautical Radio Inc., 1700 K St. N.W., Washington, D. C.

Jan. 12-16—

Society of Automotive Engineers Inc. Annual Meeting and Engineering Display to be held at the Sheraton-Cadillac and Statler Hotels, Detroit. Further information is available from SAE headquarters, 485 Lexington Ave., New York 17, N. Y.

(*Please turn to Page* 48)



For those mechanical and electro-mechanical parts that must be strong, durable, wear resistant, *design to use Chemiseal Nylon* (du Pont ZYTEL). It has the highest compressive strength, is the most rigid, has the best resistance to heat, abrasion, chemicals, solvents, oils and greases—and is the lowest priced of the standard nylon compositions.

U.S.G. Nylon service goes all the way, offering STOCK (sheets, tape, rod, tubing, special shapes), for manufacture of parts in your own plant; MACHINING (precision fabrication on high speed automatics) to your specifications; and INJECTION MOLDING (volume production to close tolerances at lowest cost).

To be sure you are securing your parts at the lowest cost, consistent with your requirement at every stage from prototype to plant scale production—*check your costs with U.S.G. "know-how"*.

For prompt service, contact one of The Garlock Packing Company's 30 sales offices and warehouses throughout the U.S. and Canada, or write

United States Gasket Company
Camden 1, New Jersey

United States Gasket *Plastics Division of* **GARLOCK**

Circle 426 on Page 19

Can a better spring save you money?

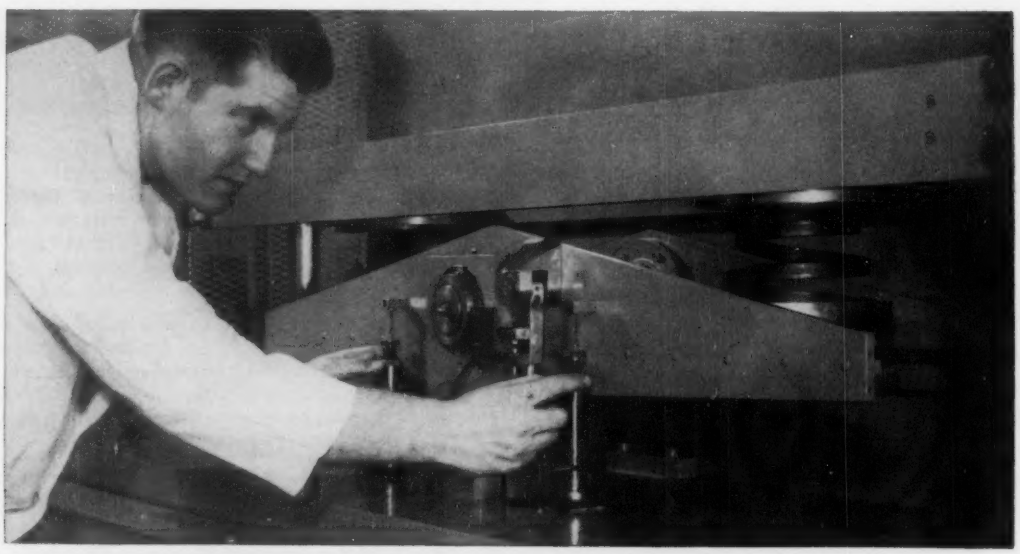
. . . then put American Spring Engineering Research Service to work for you!

WOULD you like the springs you now use to last longer? Would you like to cut their cost? Do you need design assistance on a difficult new spring application? *American Steel & Wire may be able to help you.*

We maintain complete spring testing facilities to help you solve any spring problem. Our spring engineering specialists can help you improve the *design* of your spring. We can help you determine the best possible *steel* to use. Then, we can completely check spring performance. We can simulate any spring operating condition and verify these recommendations in terms of improved service in your product.

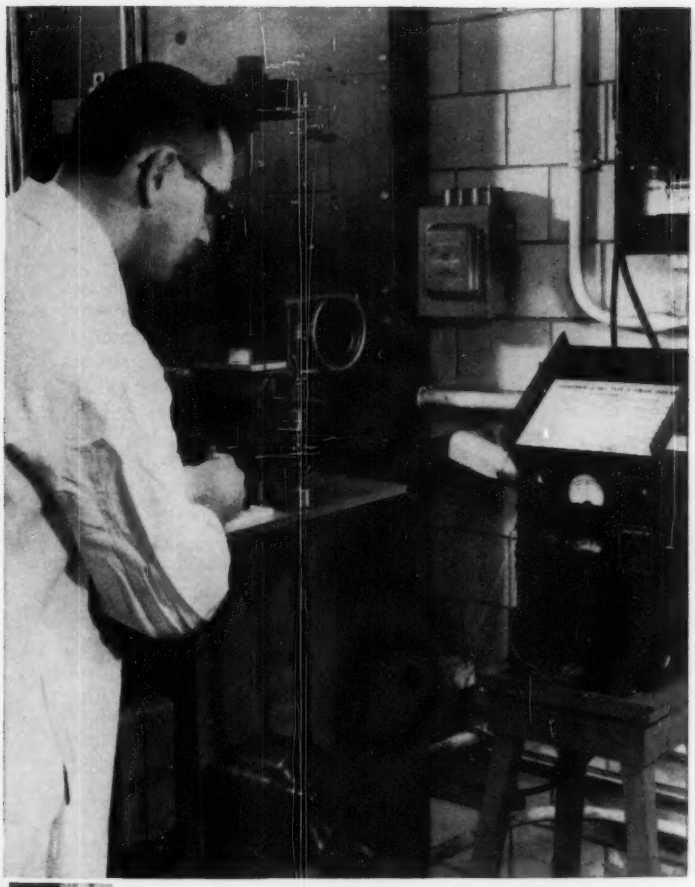
Hundreds of companies have taken advantage of this service and have profited from it. Why don't you? Just write American Steel & Wire, 614 Superior Avenue, N. W., Cleveland 13, Ohio.

USS is a registered trademark



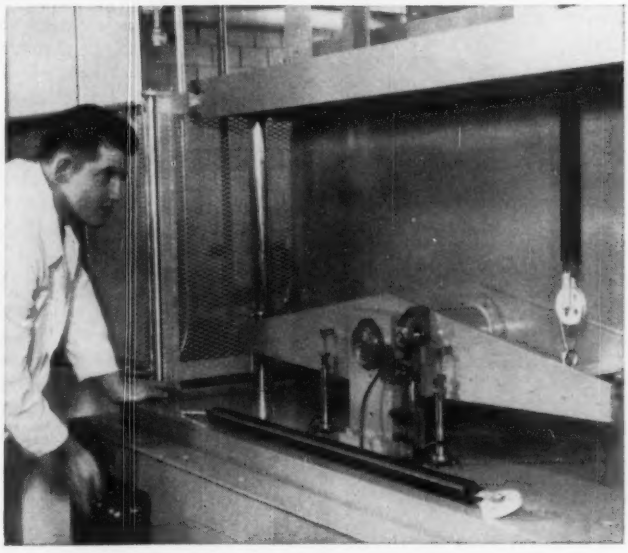
Heavy-Duty Clutch Springs Last Longer Now—Thanks to AS&W Spring Research!

The Lipe-Rollway Clutch Division, Lipe-Rollway Corporation, Syracuse, New York, asked AS&W Spring Engineering Research Service to determine if design change would lengthen the life of the flat wire compression springs used in their clutches. AS&W recommended design changes that greatly increased the spring life.



AS&W Spring Tests Make Possible New Design Rocking Chair!

40,000 springs—not one failure—American Steel & Wire helped Homecrest Company, Wadena, Minnesota, design a round wire helical torsion spring for an unusual new type of swivel rocking chair. To date, 20,000 of these chairs have been sold, but not one failure of the 40,000 springs has been reported.



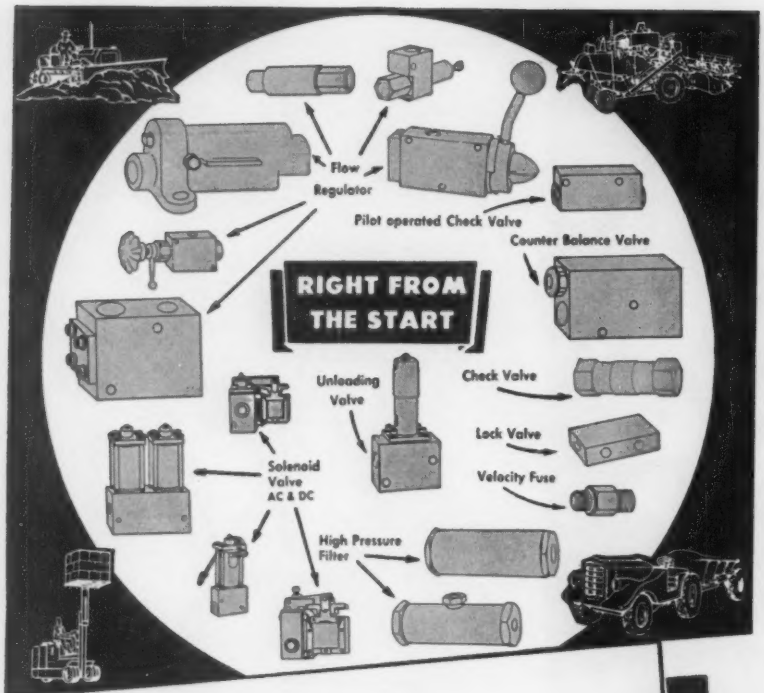
Design Change Increases Operating Life of Garage Door Springs!

The Steel Door Corporation, Birmingham, Mich., asked the AS&W Spring Engineering Research Service for a statistical evaluation of the fatigue life of this extension hook-type spring. As a result of the test, AS&W recommended a design change which has materially lengthened the operating life of the spring.

American Steel & Wire Division of USS **United States Steel**

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • Tennessee Coal & Iron Division, Fairfield, Ala., Southern Distributors • United States Steel Export Company, Distributors Abroad

Circle 427 on Page 19



CONTROLLING FLOW IS OUR BUSINESS

All of the above valves have been used in various types of applications, including Material Handling, Road Building, Machine Tools, Farm Equipment and Earthmoving.

Waterman Engineering Company has also supplied valves to the Military for Ground Support Equipment and Missile Launchers.

We invite you to send us your applications and take advantage of our experience to help analyze your problems.

Bulletins of any of these products sent on request.

Also suppliers of AN and MS qualified Flow Rate and Volume Controls to the Aircraft Industry.

WATERMAN
ENGINEERING COMPANY
725 CUSTER AVENUE · EVANSTON, ILLINOIS

(*Continued from Page 45*)

Jan. 21-23—

Southwest Electronic Exhibit to be held at the Arizona State Fairgrounds, Phoenix, Ariz. Additional information is available from exhibit headquarters, 4353 W. Missouri, Glendale, Ariz.

Jan. 26-27—

American Society of Lubrication Engineers. First Annual Gear Symposium to be held at the Morrison Hotel, Chicago. Further information can be obtained from ASLE headquarters, 84 E. Randolph St., Chicago 1, Ill.

Jan. 26-29—

Fourteenth International Heating & Air Conditioning Exposition to be held at Convention Hall, Philadelphia, under the auspices of the American Society of Heating and Air-Conditioning Engineers. The society's 64th annual meeting will be held concurrently. Further information can be obtained from exposition headquarters, 480 Lexington Ave., New York 17, N. Y.

Jan. 26-29—

Institute of the Aeronautical Sciences. Annual Meeting to be held at the Sheraton-Astor Hotel, New York. Further information is available from IAS headquarters, 2 E. 64th St., New York 21, N. Y.

Jan. 26-29—

Plant Maintenance and Engineering Show to be held at Public Auditorium, Cleveland. Additional information can be obtained from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

Feb. 3-5—

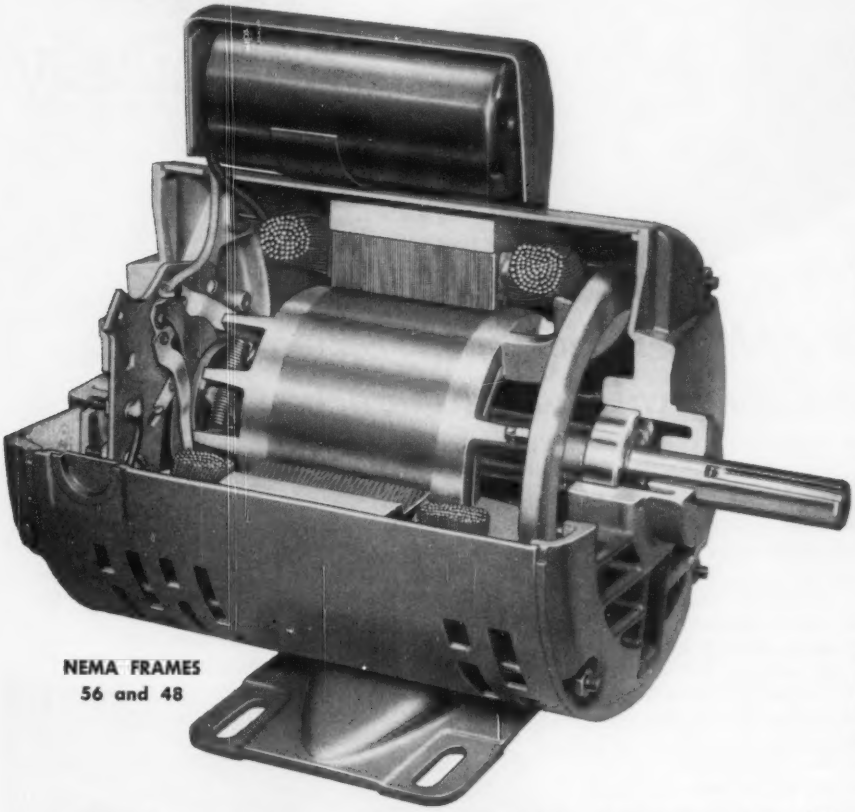
Society of the Plastics Industry Inc. Fourteenth Reinforced Plastics Conference to be held at the Edgewater Beach Hotel, Chicago. Additional information is available from SPI headquarters, 250 Park Ave., New York 17, N. Y.

Feb. 15-19—

American Institute of Mining, Metallurgical, and Petroleum Engineers. Annual Meeting to be held at the St. Francis Hotel, San Francisco. Further information is available from AIME headquarters, 29 W. 39th St., New York 18, N. Y.

Circle 428 on Page 19

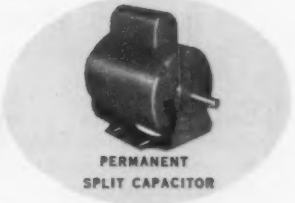
NEW R & M Fractional HP Re-Rated Motors



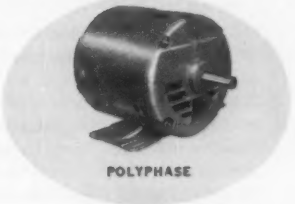
NEMA FRAMES
56 and 48

SPLIT PHASE

CAPACITOR START



PERMANENT
SPLIT CAPACITOR



POLYPHASE

OPEN AND TOTALLY ENCLOSED
SLEEVE OR BALL BEARINGS
RIGID, RESILIENT OR END MOUNTING
NEMA C FLANGE

SPECIAL PURPOSE MOTORS

MORE POWER...LESS WEIGHT AND SIZE!

Think of the advantages these new motors offer your products! Many new R&M Re-Rated Motors are less than half the weight of former designs. For example, the new R&M ¾ hp, 1725 RPM single phase motor weighs 26 pounds as compared to a former weight of 56 pounds. Performance, torque and overload service factors are well within national standards. Lightness and compactness have been accomplished by the selective use of lighter metals and more efficient double end ventilating.

Design versatility is an advantage too! R&M Re-Rated Motors in NEMA Frames 56 and 48 are available as complete "off the shelf" motors with a wide choice of mountings, bearings, mechanical and electrical characteristics in sizes from 1 to ⅛ hp. They're also available as motor parts without end heads. Write for Bulletin 450-MD.

Robbins & Myers build motors from 1/200 to 200 horsepower

Where production quantities justify, experienced R&M application engineers welcome the opportunity to furnish a design best suited to your particular power requirements.

ROBBINS & MYERS, INC.

SPRINGFIELD, OHIO | BRANTFORD, ONTARIO

MOTORS · FANS · HOISTS · MOYNO PUMPS · (INDUSTRIAL) PROPELLAIR FANS

Circle 429 on Page 19

Tailor-made, tough and chemically inert...

. . . these J-M Chempac Teflon components combat chemical and solvent action!*

SMALL OR LARGE . . . intricate or simple . . . J-M Chempac® Teflon components have proved their exceptional resistance to the constant attack of corrosive chemicals in rugged service.

Look to J-M for Teflon packings, gaskets, and moulded shapes made to your exact specifications . . . or for parts that are machined to close dimensional tolerances. Moreover, we can combine Teflon with top quality J-M asbestos to impart the exceptional sealing and heat-resistance properties of the "magic mineral." And in addition to corrosion-resistance, Teflon gives you the advantages of an extremely low coefficient of friction . . . toughness and flexibility . . . and weight-saving possibilities.

You can also obtain J-M Chempac Teflon Packings in moulded and braided types for pumps and valves . . . in a wide range of flange and envelope-type gaskets . . . in rings, cups, sheets and tapes. Your J-M Packings Distributor can supply your needs. Or write Johns-Manville, Box 14, New York 16, New York. In Canada: Port Credit, Ontario.

*TM for DuPont Tetrafluorethylene resin.

Teflon rods, tubes, tapes and sheets —in addition to components of varied sizes and shapes as indicated here—are also available from Johns-Manville. Prompt delivery of any quantity you need is assured by new J-M production facilities.

JOHNS-MANVILLE JM PRODUCTS

JOHNS-MANVILLE

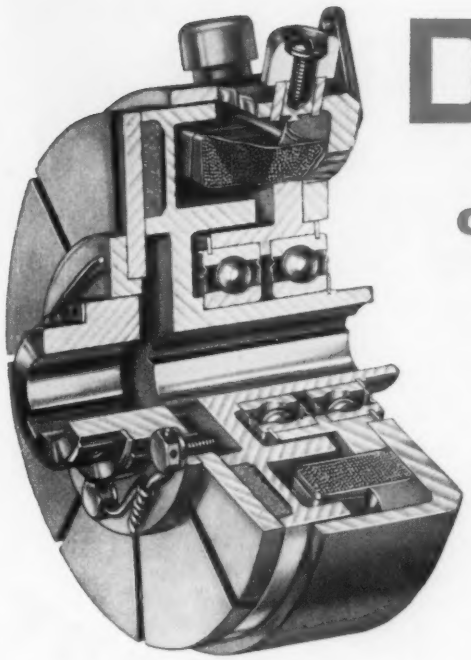
100 YEARS OF QUALITY PRODUCTS . . . 1858-1958

Circle 430 on Page 19

New—Small Sizes!

EATON DYNA-TORQ

MAGNETIC-FRICTION CLUTCHES and BRAKES



STATIONARY-FIELD, BEARING-MOUNTED DYNA-TORQ CLUTCH

Now Available in a Full Line from 1¾" to 15" Diameter

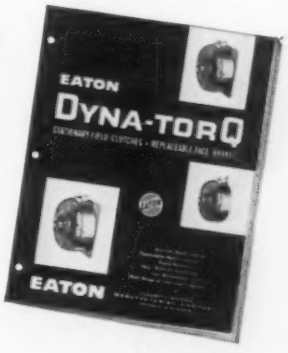
Eaton Dyna-torQ Magnetic-Friction Clutches and Brakes provide a simple, accurate, responsive method of controlling power and motion in today's complex production and processing machines.

The new smaller sizes and new design types of Dyna-torQ Stationary-Field Clutches and Brakes enable Eaton to offer a well rounded line, including flange-mounted and bearing-mounted clutches, and replaceable-face brakes. Unique features of design and construction result in worthwhile maintenance cost savings. Dyna-torQ units, easily and quickly installed on new machines or existing plant equipment, deliver many highly desirable advantages.

Dyna-torQ Magnetic-Friction Equipment Offers these Important Advantages:

- ★ Accurate power control
- ★ Dependable motion control
- ★ Rapid response
- ★ Easy "built-in" installation
- ★ Low maintenance costs
- ★ Compact plug-in type controls—may be remotely mounted
- ★ Inter-changeability of parts

Send for this new illustrated bulletin giving complete description and specifications covering Dyna-torQ Stationary-Field Clutches and Replaceable-Face Brakes.



Dyna-torQ Equipment is Available through Dynamatic Distributors in all Leading Cities

EATON

DYNAMATIC DIVISION
MANUFACTURING COMPANY
3307 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

Circle 431 on Page 19

FOR THE MACHINERY PART

THAT TAKES THE BEATING

A cut-off knife made of HAYNES STELLITE alloy No. 19 slices through molten glass at 2200 deg. F. Despite the intense heat of the glass being molded into tumblers, and the severe erosive action of the glass on metal, the cut-off knife maintains a 0.015-in. clearance between itself and the mold ring . . . *far longer than any other material ever used.*

Are you looking for a tough metal part to improve your machinery? It will pay you to look into HAYNES alloys. There are more than 15 from which to choose, including HAYNES STELLITE cobalt-base alloys, HAYNES iron-base alloys, HAYSTELLITE cast tungsten carbide, and HASTELLOY nickel-base alloys. They are available as castings, forgings, completely fabricated parts, or as sheet and bar stock. Parts can be furnished machined or ground to specified size and finish.

Our engineers will help you pick the right HAYNES alloy to resist many conditions of wear, heat, or corrosion.

HAYNES Alloys *will do the job!*

HAYNES ALLOYS

HAYNES STELLITE COMPANY

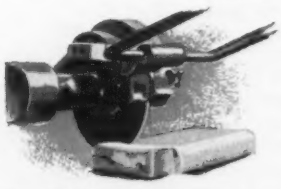
Division of Union Carbide Corporation

Kokomo, Indiana

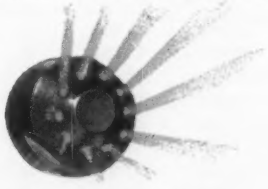
UNION CARBIDE

The terms "Haynes," "Haynes Stellite," "Hastelloy," "Haystellite" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

TYPICAL "HAYNES" ALLOY MACHINERY PARTS



Tough, long-lasting metal-cutting saws over 20 inches in diameter, made of HAYNES STELLITE alloy sheet, slice the tops off copper ingots.



Steam atomizer fuel burner nozzles of HASTELLOY alloy C resist corrosive agents and erosion for months, retaining essential contours.

High-temperature strength and corrosion resistance of diesel combustion chambers made of HASTELLOY alloy C make them "good for life of the engines."

Circle 432 on Page 19

DESIGNING WITH ALUMINUM

NO. 29

This is one of a series of information sheets that discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series supplied on request. Address: Advertising Dept., Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

DESIGNING WITH ALUMINUM SCREW MACHINE PRODUCTS

RECENT INNOVATIONS in screw machine equipment have made possible great strides in the accuracy, versatility and output rates of both single and multiple spindle machines. These advancements, such as spindle-stopping attachments, increased spindle speeds and numerous secondary-operation accessories, along with the superior working qualities of improved aluminum alloys, have created new opportunities for the designer of precision, high-volume production parts.

Advantages of the Screw Machine Process

The screw machine process serves two primary design considerations: high quality and low production cost. Thus, whenever design of the parts permits, screw machining is usually chosen in preference to other fabricating methods.

High quality of product is, in part, the result of high quality starting materials. The rod, bar and wire used in screw machine work is wrought during the forming process, thus acquiring good density, low porosity and fine grain structure. These properties are conducive to excellent machinability, faithful detail and fine surface finish.

Materials having these properties, when worked in a process of inherently high accuracy and close control, produce parts of dependable dimensions and great uniformity. Accurate concentricity and mating-part fits are attained, with closer tolerances possible than in any other primary fabricating method. For example, Class 3 threads, and other features of similar fineness, may be turned without undue difficulty.

The properties contributing to high quality also contribute to low production cost. Fewer secondary operations are necessary, because of the fine as-machined surface finishes, the intricacy of detail and the dimensional accuracy possible in the basic screw machine process. Rejection rates are low, and subsequent automatic handling processes are facilitated by the uniformity of the parts.

Reduced unit costs also stem from the wide range of available high speed equipment and mill-standard raw materials, the relative simplicity of machining set-up and the faster delivery of finished parts. Expensive dies and fixtures are not required. And because stock cutting tools generally may be used, tooling and maintenance costs are minimized. In-process modification of parts is relatively quick and easy.

Added Advantages with Aluminum

The designer will find these native features of the screw machine process even more valuable when the physical and mechanical advantages of aluminum are considered.

Fig. 1

TYPICAL PROPERTIES OF ALUMINUM SCREW MACHINE ALLOYS COMPARED WITH STEEL AND FREE-CUTTING BRASS

	Tensile Strength (psi)	Yield Strength (psi)	Shear Strength (psi)	Elongation (% in 2 in.)	Hardness (Brinell)	Modulus of Elasticity (psi)	Density (lb./cu. in.)	Electrical* Resistivity	Thermal† Conductivity	Thermal Expansion (68 to 580 F.)
B1113 Steel (Cold Drawn)	85,000	75,000	—	14	170	29.0×10^6	.283	20.0	360	12.8×10^6
C1018 Steel (Cold Drawn)	82,000	70,000	—	20	163	"	"	"	"	"
B1112 Steel (Cold Drawn)	82,500	71,000	—	15	170	30.0×10^6	"	"	"	"
#271 Brass (Free Cutting)	58,000	45,000	34,000	25	143	14.0×10^6	.307	6.6	800	20.5×10^6
ALUMINUM ALLOYS										
2011-T3	55,000	43,000	32,000	15	95	10.2×10^6	.102	4.8	990	22.9×10^6
2011-T8	59,000	45,000	35,000	12	100	10.3×10^6	.102	4.8	990	
2014-T4	62,000	42,000	38,000	20	105	10.6×10^6	.101	5.7	840	23.3×10^6
2017-T4	62,000	40,000	38,000	22	105	10.5×10^6	.101	5.7	840	23.5×10^6
2024-T4	68,000	47,000	41,000	19	120	10.6×10^6	.100	5.7	840	23.2×10^6
6061-0	18,000	8,000	12,000	30	30	10.0×10^6	.098	3.8	1190	23.5×10^6
6061-T4	33,000	21,000	24,000	25	65	10.0×10^6	.098	4.3	1170	
6061-T6	45,000	40,000	30,000	17	95	10.0×10^6	.098	4.3	1170	
7075-T6	83,000	73,000	48,000	11	150	10.4×10^6	.101	5.7	840	23.6×10^6

*In microhms/cm. at 68 F. †In B.T.U. per inch per square foot per hour.

While almost all aluminum alloys are well adapted to machining, a number of them are especially designed for turn-cutting operations. The wide range of these alloys permits matching the characteristics of the alloy to the working requirements of the part. Some aluminum alloys provide strength properties approaching those of cold-drawn mild steel. Others have machining qualities equal to free-cutting brass. All have good corrosion resistance under proper conditions of use.

Alloy 2011, for example, the most popular aluminum alloy for screw machined products, is an especially free-machining metal with excellent mechanical properties, accepting heavy feeds at high cutting speeds. This alloy, and some of the other aluminum alloys available for the designer's selection of optimum property combinations, is listed in Fig. 1 along with representative brass and steel materials.

Alloy 2017, which like 2011 is one of the most frequently selected aluminum alloys for screw machine work, has somewhat higher ductility than 2011, while retaining good machining qualities.

Strongest of these copper-bearing aluminum alloys is 2024, which can be readily roll-threaded, spot welded and finished to fine surface qualities. It is widely used for durable fittings and fasteners.

The 6061 and 7075 alloys listed in Fig. 1 illustrate the versatility of aluminum for screw machine product applications. Note that 6061, for example, increases five-fold in yield strength from its annealed condition to its T6 temper stage, which is attained simply by heat treating. This 6061 material is readily welded by all methods, may be torch or furnace brazed, and has good resistance to corrosive attack as well as excellent machinability.

Alloy 7075 offers the strength qualities of cold-drawn steel *at one-third of the weight per volume* in an easily machined, spot weldable material.

More Helpful Design Properties

In addition to their qualities of superior machinability and high strength-to-weight ratio, these aluminum alloys offer many other properties helpful to the screw machine product designer.

For electrical usages, aluminum alloys offer conductivity, in proportion to weight, ranging up to double that of electrolytic copper. Similarly, thermal conductivity is higher than in free-cutting brass and three or four times greater than in ferrous metals. This quality affords quick, even distribution of heat, where heat is desired, while providing rapid dispersion of undesirable heat. Thus, aluminum terminals, fittings and other parts designed for screw machine fabrication are of great value in electrical equipment, appliances and other high-volume production items.

Another unique property of aluminum, valuable to many modern designers, is its retention of structural strength at low temperature levels. Aluminum alloys actually increase in tensile strength and elongation, without embrittlement, as temperatures drop. The increasing demand for precision fittings and accessories in liquid-gas fueled missiles, for example, gives great significance to this unusual feature of aluminum for screw machine parts.

Still another valuable design property of aluminum is superior resilience under stress, especially in the stronger alloys, due to low modulus of elasticity. In a component subject to normal operating loadings, not involving excessive impulsive shocks or fatigue effects, the ability, "U," of a metal to absorb energy from tensile or compressive strains may be expressed as:

$$U = V\frac{S\epsilon}{2E}$$

where stress S, in psi, does not exceed yield strength; V is the volume of metal under this stress; E is elastic modulus.

The relative capacity of aluminum to absorb energy may then be observed, for equal volumes and equal elastic strengths, as the simple ratios:

$$\frac{\text{U aluminum}}{\text{U brass}} = 1.36, \text{ and } \frac{\text{U aluminum}}{\text{U steel}} = 2.91$$

For equal elastic strengths and equal weights:

$$\frac{\text{U aluminum}}{\text{U brass}} = 4.1, \text{ and } \frac{\text{U aluminum}}{\text{U steel}} = 8.1$$

(Equations derived from values in table below—taken from ASM Metals Handbook.)

Metal	E (psi)	Density lbs./cu. in.
Aluminum (2011)	10.3×10^6	.102
Free Cutting Brass	14×10^6	.307
Steel (B1112)	30×10^6	.283

Variety of Finishes Applicable

Among further advantages of aluminum screw machine products is the great variety of mechanical, chemical and electro-chemical finishes applicable to these alloys. While aluminum screw machining alloys have attractive natural appearance, artificially induced finishes may be preferred or required for many applications.

Decorative effects may be obtained by permanent color anodizing or by applied coatings. Other finishes are used to reduce non-lubricated friction between moving surfaces in contact, to improve resistance against abrasion and corrosion, to provide better adherence of paints or adhesive materials, and for many other reasons. Some of these available finishing processes are described in Fig. 2 on following page.

Some means of corrosion protection may be required when aluminum screw machine products are used in contact with dissimilar metals in a corrosive environment. Various means may be used to provide this protection.

Aluminum Offers Cost Advantages

Further help in solving the designer's problems in production economy is offered by the behavior of aluminum in shop handling and machining. The mill-standard starting materials are available, in broad size ranges, from distributor stocks throughout the country. Providing three times as much volume per pound as heavier common commercial metals, aluminum use reduces freight and shop handling costs for both raw materials and finished products. Natural corrosion resistance reduces or eliminates need for special protective attention under storage.

In the machining process, aluminum materials offer more rapid dissipation of heat, long tool life and greater stability of as-machined finish. The lightweight, finely-divided chips are easy to remove from production parts and machinery. Thus, the advantages of designing with aluminum alloys are found in all phases of cost, convenience, fabrication and function.

What the Designer Conceives... Aluminum Achieves

To help designers make full use of up-to-date developments, the following

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Fig. 2

SOME AVAILABLE FINISHES FOR ALUMINUM SCREW MACHINE PRODUCTS

Type of Finish	Name of Finish	Principle Purpose of Finish
Mechanical	Grinding	To remove surface imperfections.
	Polishing, buffing and coloring	To remove surface imperfections and to achieve decorative finish.
	Scratch brushing	To obtain a coarse- or smooth-lined texture.
	Satin finish	To obtain a soft, smooth sheen.
	Burnishing	To impart fine finish to a large number of small parts.
	Sand blasting	To produce a uniform matte surface.
Chemical	Caustic Etch	Decorative "frosted" finish.
	Crystalline chromate	Paint base.
	Chromate-phosphate-fluoride	Paint base.
	Phosphoric acid	Paint base.
	Chemical polishing	Bright finish or base for anodizing.
	Zincate	Base for electroplating.
Electrolytic Oxide	Sulfuric acid anodize	Hard, corrosion-resistant oxide film, base for dyed coatings.
	Chromic acid anodize	Hard, corrosion-resistant oxide film.
	*Hard anodizing	Extremely hard, corrosion- and wear-resistant film.
	Electrolytic polish	High light reflectivity.
Electroplating	Chromium plate	Abrasion-resistant and decorative.
	Copper plate	To promote solderability, decrease electrical surface-resistance.
	Silver plate	Decrease surface resistance.
Painting	Paint, lacquer, enamel	Decorative, corrosion resistant.
	*Porcelain enamel	Hard, decorative, corrosion-resistant coatings.

*For use only with 6061 aluminum alloy.

checklists summarize the advantages of modern screw machine production and the advantages of aluminum:

12 Advantages of Screw Machine Production

1. Starting material is a wrought product which gives high properties in the finished part.
2. Very fine threads possible—as well as accurate threading.
3. Excellent finishing possibilities—anodizing, etching, buffing, etc. As-machined finish gives very fine surface.
4. Closer tolerances and more intricate parts possible than with other methods. Mating parts match better.
5. Excellent concentricity is guaranteed.
6. Fewer rejects for porosity when compared to a cast part.
7. Lower costs for production tooling, dies, set-up; faster delivery of finished parts possible due to fast availability of tooling, speed of set-up.
8. Modification of parts in production easier and less costly.
9. Wide range of equipment and facilities available throughout the country.
10. Fewer secondary operations necessary; possible to avoid secondary finishing by using the as-machined surface.
11. Lower costs for actual production due to high rates of production with available new equipment.
12. Lower costs for finished parts due to competitive pricing among large number of suppliers.

12 Advantages of Aluminum

1. Light weight—moving parts present less resistance to applied force, wear less; chips float out of recesses better for cleaning finished parts. Easier handling of raw material in plant, lower freight costs on finished parts.
2. Non-magnetic.
3. Corrosion resistant—can often eliminate finishing.
4. Non-sparking.
5. Lower raw material cost per part.
6. Greater conductivity—helps dissipate machining heat.
7. Some alloys less susceptible to radiation absorption.
8. More alloys available than some other metals, allowing a particular alloy to be related to a particular part.
9. Less price fluctuation on raw materials.
10. Stock readily available. Size range broad and well stocked at distributors throughout the country.
11. New procedures in producing aluminum screw machine stock now give greater tool life and higher production. New processes such as Electrofilming and Kanigen Coating have overcome old problems as galling and binding.
12. Technical literature for designing purposes readily available.

Engineering advisory services and technical literature on conversions to aluminum in screw machining are available without obligation to interested manufacturers. For further information and professional design assistance, inquire through the Kaiser Aluminum sales office listed in your telephone directory.

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see our catalog in 9 PRODUCT DESIGN FILE. or write for copy

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Circle 435 on Page 19→

Get better protection...more reliable

...WITH GENERAL ELECTRIC

operation for your product

TRI 55 CLAD ENCLOSED MOTORS

HERE'S WHY:

External Features: Moisture-resistant sealing compound is applied on carefully machined rabbets to assure better protection against moisture and dust. Corrosion-resistant, non-sparking fan on all enclosed fan-cooled Tri/Clad '55' motors resists action of the strongest acids and alkalis. Jet action cools motor effectively and efficiently for long-life operation.

Lead connections are protected from contact with moisture and dirt by a cork-neoprene gasket between halves of the easy-access conduit box.

Further, a new lead positioner gasket between conduit box and frame is impervious to cutting fluids—protects internal parts effectively.

Internal Features: Mylar* polyester film insulation and Formex† magnet wire provide greater moisture and heat-aging protection. Water-resistant stator coating also guards against failure due to moisture. And G.E.'s advanced bearing system gives years more service.

General Electric offers you the most complete line of enclosed motors in the industry, including standard enclosed, severe-duty (for highly corrosive atmospheres), and explosion-proof motors.

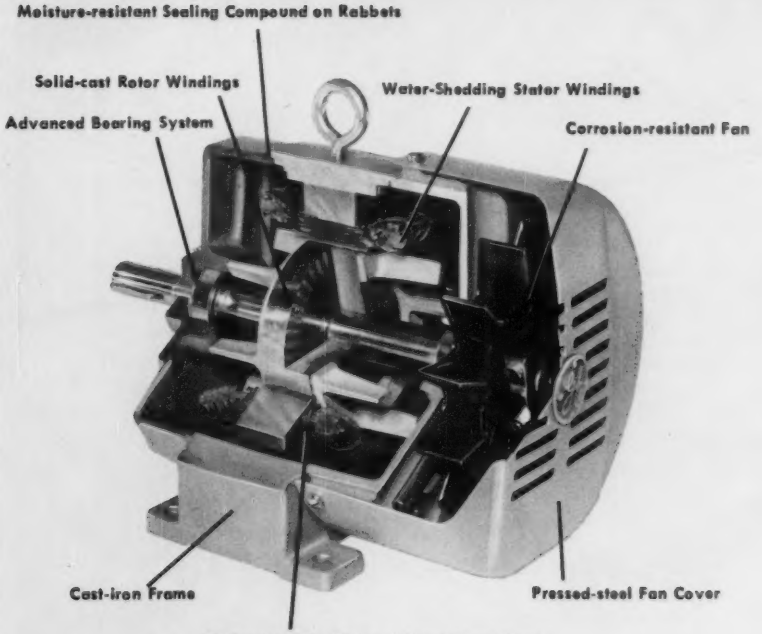
CONTACT your nearest G-E Apparatus Sales Office now for *personal proof* on why G-E Tri/Clad '55' enclosed motors can do a better job for your applications. And ask for a free copy of these descriptive motor bulletins: 1-5 hp—GEA-6240, GEA-5980, and GEA-6341; 7½-125 hp—GEA-6602. Or write for them to Section 840-20, General Electric Co., Schenectady 5, New York.

*Registered Trade-mark of DuPont Co.

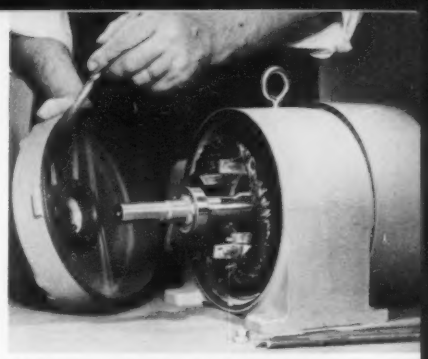
†Registered Trade-mark of General Electric Co.

GENERAL ELECTRIC

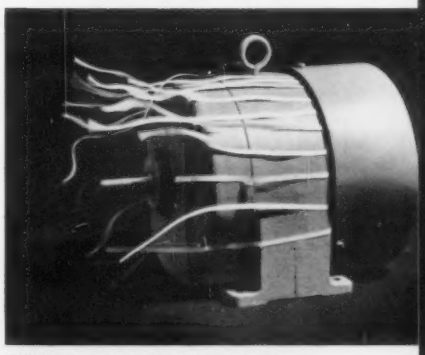
COMPARE THESE TRI 55 CLAD FEATURES



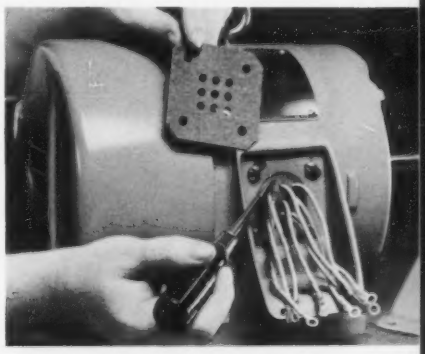
Standard enclosed Tri/Clad '55' motor



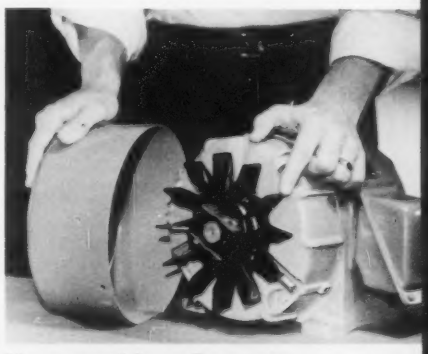
Water-resistant Rabbets protect against moisture, dirt, and abrasive dust for longer life.



Efficient Jet Cooling System spreads a smooth blanket of air over the entire motor frame.

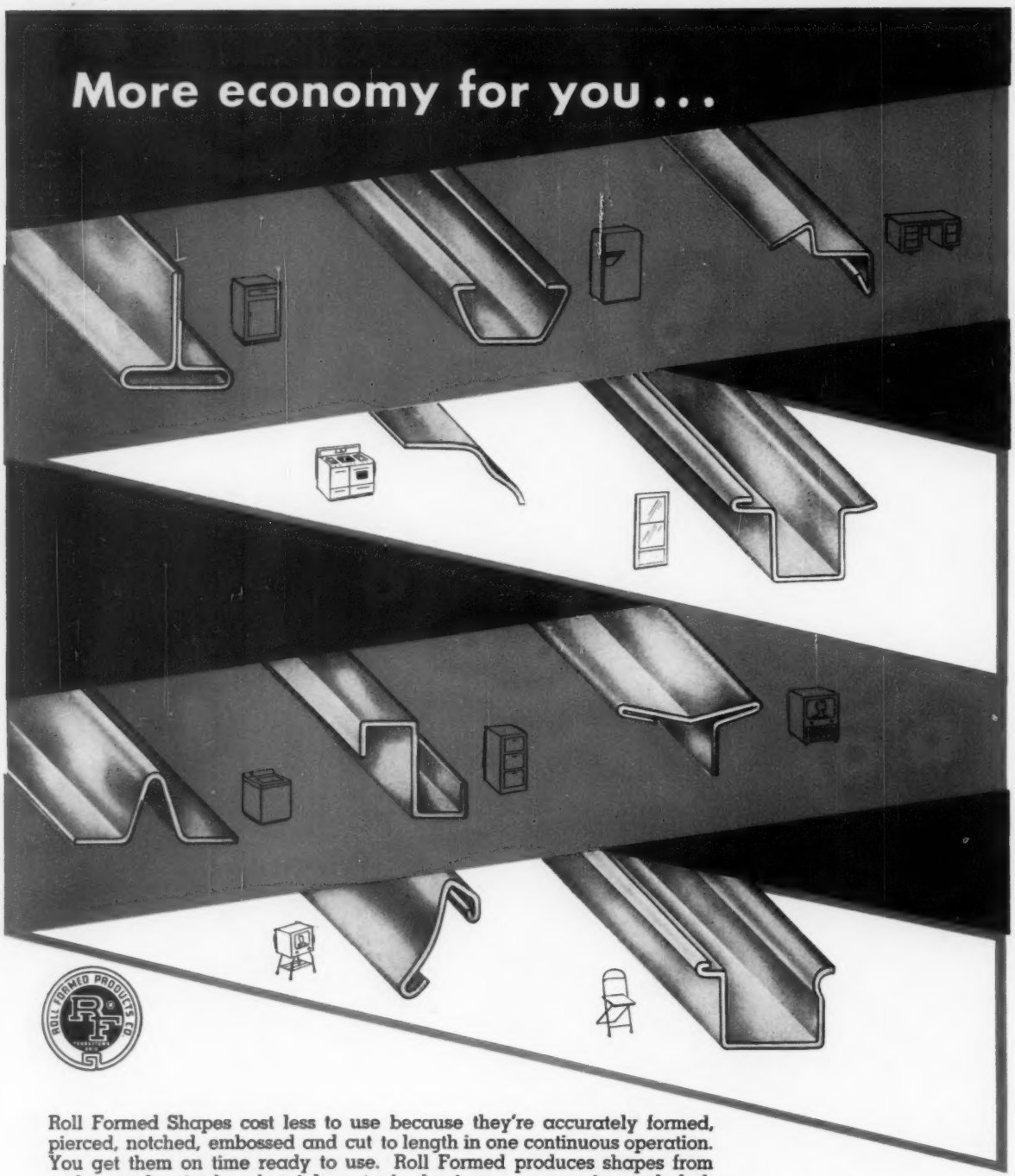


New Lead Positioner and gasket saves connection time; is impervious to cutting liquids.



Non-sparking Fan effectively cools the motor—resists action of strongest acids and alkalis.

More economy for you...



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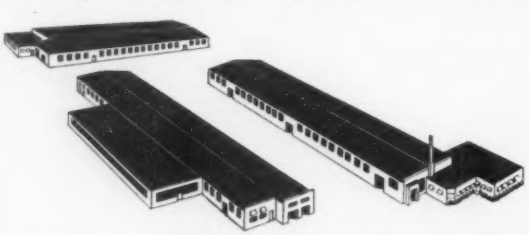

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Some Ideas

for your file of practical information on drafting and reproduction from

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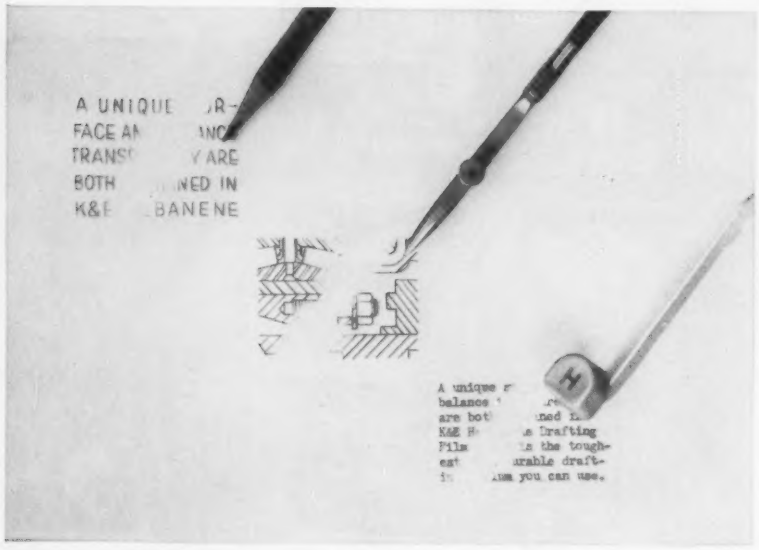

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All K&E paper, cloth and film has one extremely individual characteristic. It's what K&E calls its "engineered surface"... a unique surface designed and applied by K&E, right in its own plant, to every roll and sheet of prepared tracing paper, cloth and film. It means controlled drafting qualities far beyond anything the base material alone can normally provide, with a surface tooth that's exactly right and uniform. Whatever's penciled, inked or typed onto it goes on crisply and sharply . . . shows up clearly and stays that way. Furthermore, the "engineered surface" lets you erase if you want to, easily and quickly and without any of those leftover ghost lines that drive you crazy when they show up in reproductions. And remember, only with K&E do you get all the advantages of an "engineered surface," no matter which paper, cloth or film you're interested in.

About HERCULENE (TM) The Newest of Films

Frankly, we think K&E Herculene Drafting Film is a real discovery. It has all the properties of the K&E "engineered surface" . . . exceptional "take," adhesion and erasability . . . plus the toughness and durability of its Mylar® base. What's the latter? It's a polyester film, developed by DuPont, that's uncommonly strong and virtually indestructible . . . waterproof and almost immune to the effects of age, heat, ultraviolet exposure and handling. With our K&E "engineered surface" added, it becomes K&E Herculene Drafting Film . . . the toughest, most durable drafting medium yet to reach the drafting room. And the surface will last indefinitely, without flaking off or chipping off.

Some Points About Paper...

K&E Albanene® Tracing Paper is the largest selling tracing paper in the world today. Why? Because Albanene is the *only* prepared tracing paper which has an "engineered surface." All other brands depend for their pencil tooth solely on the natural surface texture of the paper itself, which varies from fine to coarse . . . often on the same sheet.

Albanene invariably gives you sharp, clear pencil lines, superb reproductions. It has a solid transparentizer that is chemically stable and can't leak out, ever. This permanent transparentizing means that you'll never get white, opaque spots, even from contact with drafting tape. Try the drafting tape test yourself.

. . . and its package

And now, all Albanene paper in rolls is packaged in the new square carton for better protection and easier storage. Your rolls stay neat and clean while in use, and the cartons will do double duty in helping you to store finished tracings. In fact, some companies are rearranging their filing systems by using Albanene cartons, which hold large numbers of rolled-up drawings and stack simply and neatly.

Some Facts About Cloth

When you want cloth, think first of K&E Phoenix® Tracing Cloth. Besides the K&E "engineered surface" with the superb "take", adhesion and erasability for pencil, ink or typing, K&E Phoenix has all the advantages of a water-resistant, chemically-inert coating that won't soften even under high heat and won't discolor, become brittle or flake off the base. You can even clean both sides with a damp cloth, without worrying about moisture stains.

And Some Tips On Erasing

All K&E drafting media give you excellent erasability, but there's a right way to erase on each one. On cloth and film, harsh, gritty erasers can destroy the surface. You'll get the best results with plastic erasers, such as the Richard Best "Tad" and the Eberhard Faber "Race Kleen." Moisten them for removing ink and stubborn typing; use them as they are for removing pencil lines. Large areas of ink can be removed completely without damage by using a moist cloth and Bon Ami cleanser. On Albanene, electric erasing machines are fine if used with a soft eraser.

The Choice Is Up To You

When it comes to selecting K&E paper, cloth or film for the job at hand, we have to leave the choice to you. We're not being indecisive . . . it's just that you're the only one who knows the particular problem you have and which product solves it best. But remember . . . K&E has a *complete* line of paper, cloth and film . . . and only K&E puts a special "engineered surface" on all three media to provide a well-balanced, uniform surface suited to the base material.

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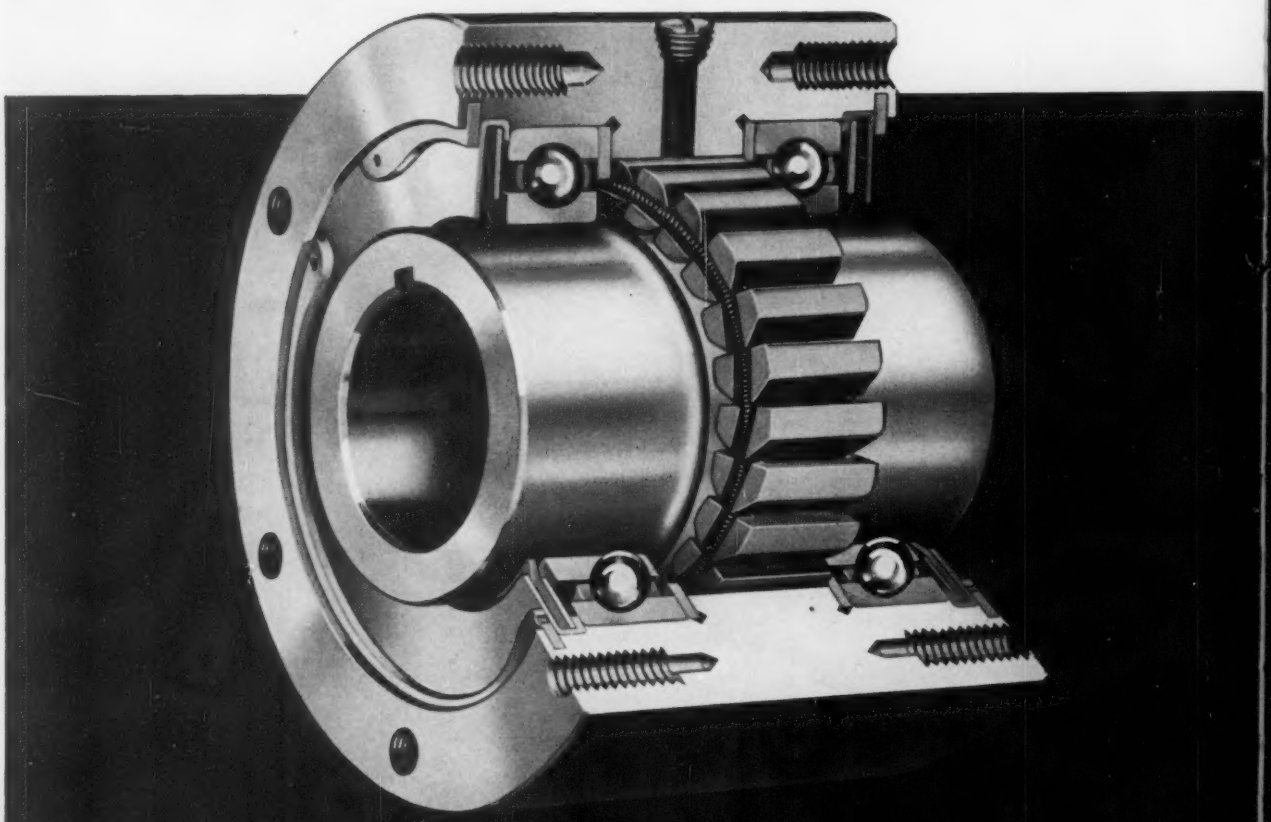
The OVER-RUNNING CLUTCH With



OVER-RUNNING · INDEXING BACKSTOPPING

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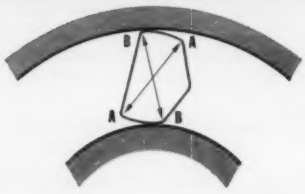
Formsprag Clutches are used throughout industry, from business machines to aircraft, in bore sizes from ¼″ to 12″. Several informative bulletins available, including: "Design Considerations for High-Speed Over-running Clutches," "Ten Design Ideas", "Seven Ways to Reduce Space and Costs", plus the complete Formsprag catalog. Write for any one or all.

HERE'S



The Formsprag clutch consists of a full complement of shaped sprags, or wedges, located between concentric inner and outer races. Power is transmitted from one race to the other by the wedging action of the sprags. Each sprag is so shaped that dimension AA is greater than BB. Rotation of one race in the "driving" direction causes the sprags to wedge, transmitting torque in full from one race to the other.

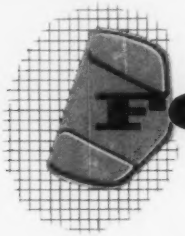
Greatest Torque
Per Inch – Per Ounce

Modern power transmission design demands the utmost torque capacity in an absolute minimum of space. That's why designers in every field specify Formsprag clutches . . . the *modern* way to transmit power on over-running, back-stopping and indexing applications.

Along with highest possible torque capacity for its size and weight, every Formsprag clutch offers such additional benefits as internal simplicity (just four basic parts), no measurable backlash, light weight, compactness, extreme precision and long, trouble-free life. Formsprag's exclusive, patented principle is unlimited in application, yet this full-complement sprag type clutch is extremely simple in design and operation.

There is a size and model Formsprag clutch for every application. Standard models include sleeve bearing, ball bearing, miniature, and large bore backstop types. These are shown in the current Formsprag catalog, complete with specifications, performance data and design suggestions. Ask your Formsprag distributor, or write direct for your copy. For special applications, Formsprag engineers will recommend a modified standard or design a special. Send details of your requirements.

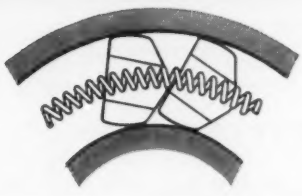
FORMSPRAG COMPANY
23603 Hoover Road, Dept. 100
Warren (Detroit), Michigan
In Canada: Renold Chains Canada, Limited
In United Kingdom: Renold Chains, Limited
Distributors in Principal Cities

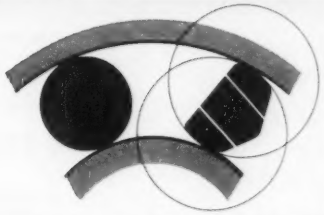


FORMSPRAG CLUTCHES

World's Largest Exclusive Manufacturer of Over-running Clutches

HOW IT WORKS

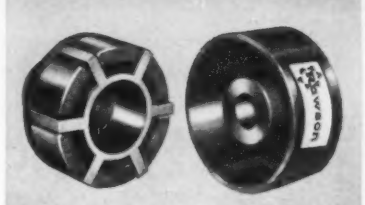




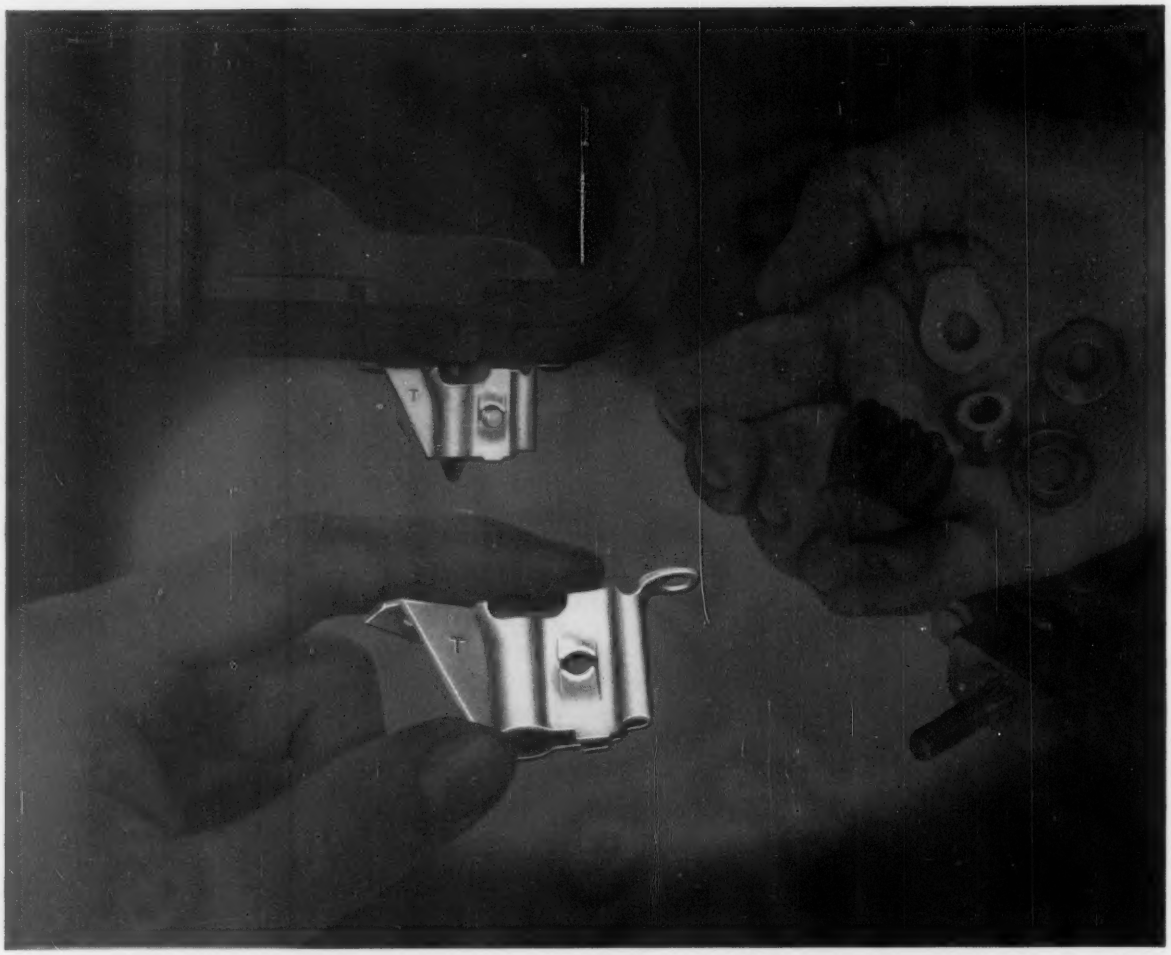
An expanding coil spring keeps the sprags in light contact with both inner and outer races. There is thus no lost motion, the driving torque being instantaneously transmitted between races. The Formsprag Clutch is so designed that it will transmit a greater torque in relation to its size and weight, than any other comparable type of clutch . . . specify Formsprag on over-running, back-stopping and indexing applications.

Forcing a ball or roller into a curved, wedged space is an old over-running clutch principle. The sprag is, in effect, a "roller" of increased diameter with greater contact surface in a given annular space. Formsprag Clutches engage at constantly changing contact points. Clutch life is prolonged and backlash eliminated. Also, with the inclined surfaces discarded, more sprags can be inserted to increase torque capacity.

FOR NO-LOAD STARTS



Specify Rawson Automatic Centrifugal Clutches and Clutch Couplings. They protect the prime mover, eliminate need for costly reduced voltage starting equipment, permit use of less expensive smaller motors to start high inertia loads. Completely automatic and entirely mechanical in operation. Rawson clutches provide full overload protection, never need adjustment. Write for the new Rawson Clutch Catalog now.



Engineered by Tinnerman...

3-way savings for Chrysler Corporation when one **SPEED NUT**® replaced 5 parts

Four parts eliminated...

Parts cost reduced 40%...

Assembly costs cut 12%...

All these savings were accomplished when the Chrysler Corporation switched to a Tinnerman-engineered SPEED NUT Brand Fastener developed to hold car and truck window vents in place. The all-spring-steel fastener serves as a friction brake to hold the vent at any desired position.

You, too, can achieve savings like these on parts for your assemblies . . . a no-obligation Tinnerman SPEED NUT Fastening Analysis will quickly locate the places. Your Tinnerman sales representative will discuss your problem, arrange for the Analysis. He's listed in your Yellow Pages under "Fasteners." Or write to:

TINNERMAN PRODUCTS, INC.
Dept. 12 • P. O. Box 6688 • Cleveland 1, Ohio

TINNERMAN

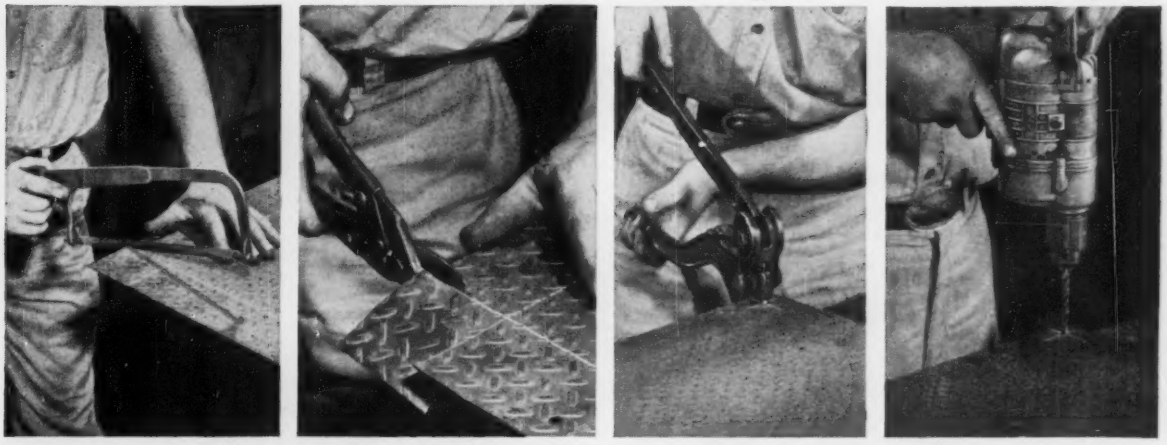
Speed Nuts®

FASTEST THING IN FASTENINGS®

CANADA: Dominion Fasteners Ltd., Hamilton, Ontario. GREAT BRITAIN: Simmonds Aerocessories Ltd., Treforest, Wales. FRANCE: Simmonds S. A., 3 rue Salomon de Rothschild, Suresnes (Seine). GERMANY: Hecaus-Dandy GmbH, Heidelberg.

ORDINARY SHOP TOOLS

can cut, bend, hammer, drill, shape, roll saw, snip



SMALL PATTERN INLAND 4-WAY® SAFETY PLATE

You don't have to spend a penny for special equipment. With just the normal tools available in your plant you can work with Small Pattern Inland 4-WAY SAFETY PLATE—use it for dozens of maintenance jobs.

Small Pattern 4-WAY SAFETY PLATE is only 18 gage, weighs only 2.4 pounds per square foot, yet has all the slip-resistant traction and safety features that has made regular 4-WAY SAFETY PLATE famous. Small Pattern 4-WAY costs less to use—less per square foot covered—than other similar materials.

It's tough, rugged, built for years of wear, yet it is light and flexible enough to carry wherever needed—work into any required form. Try it. It's firesafe, non-absorptive, easy to keep clean—the ideal material for fast, easy, low-cost maintenance use.

a few of the ways you can use light gage Safety Plate:

kick plates
tool racks
wall covering
treads on wood steps
round or square column protectors
thresholds
truck beds
resurfacing
machines tool tables
covering over worn cement stairs

AVAILABLE FROM YOUR STEEL SERVICE CENTER in 18 gage, cut to your needs in widths up to 42″ and lengths up to 152″.

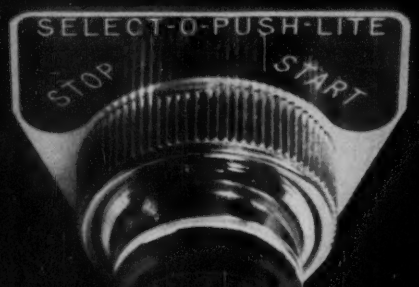
AMERICAN STEEL WAREHOUSE ASS'N.

INLAND

4-WAY SAFETY PLATE
® Registered U. S. trademark

INLAND STEEL COMPANY
30 West Monroe Street, Chicago 3, Illinois

SELECT-O-PUSHLITE



ANNOUNCING

TWO NEW SPACE-SAVING, COST-SAVING WESTINGHOUSE PUSHBUTTONS

Either of these two new pushbutton designs can replace three separate units on your control panel! Save you up to 60 percent on panel space!! Save you 25 percent on initial cost!!!

Both function as a start button, a stop button and an indicating light—all in one compact, oiltite selector unit!

SELECT-O-LITE is a low-voltage *release* unit which is operated by a mere twist of the button—to on-off, start-stop—any combination you desire.

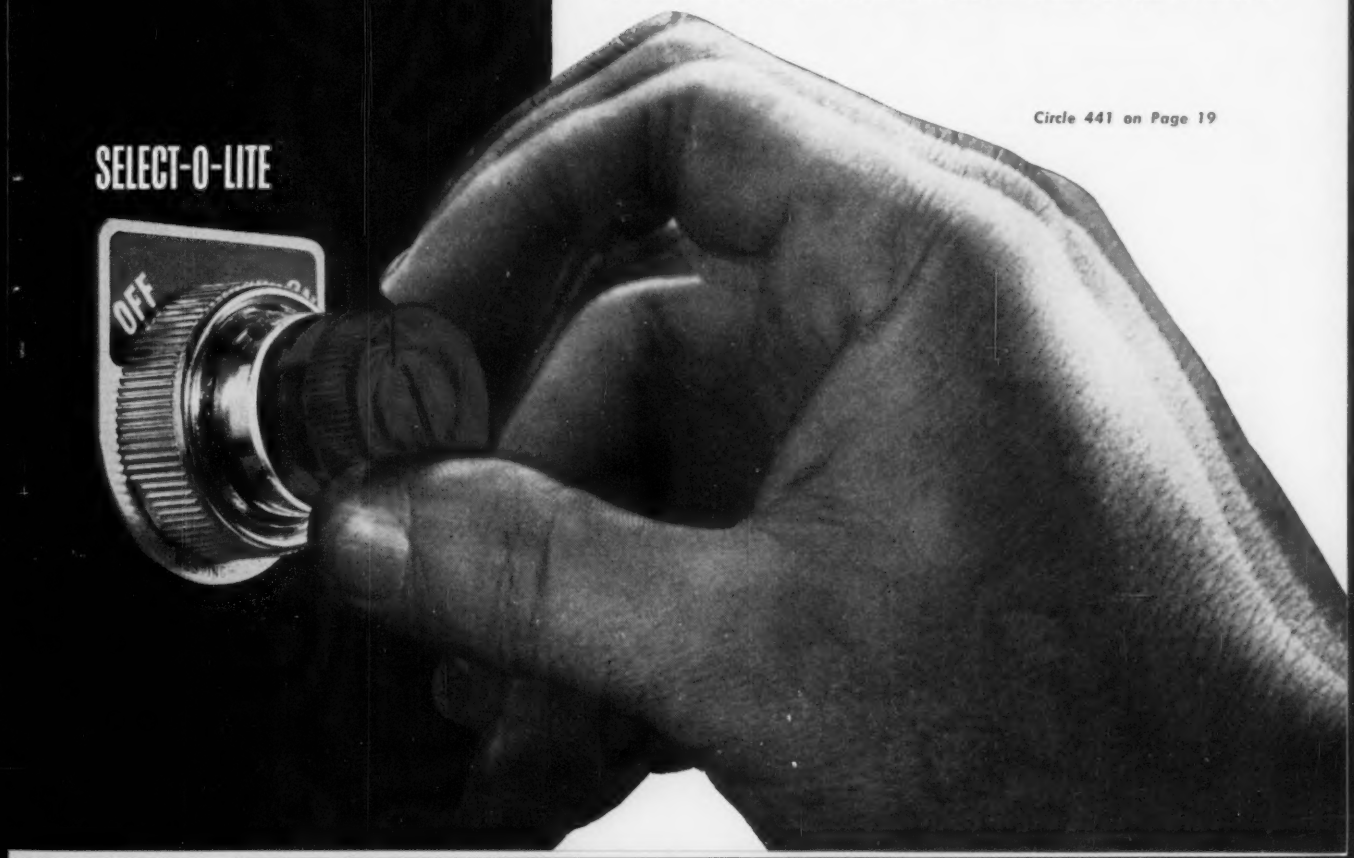
SELECT-O-PUSHLITE is a low-voltage *protection* device which operates only when the button is turned, *then pressed*—an added safety feature for critical operations.

Select-O-Lite and Select-O-Pushlite are available from Westinghouse—the same company that first brought you Pushlite and Push-To-Test pushbuttons. For detailed dimensions and ordering information, please contact your nearby Westinghouse sales office. Or write: Westinghouse Electric Corporation, Standard Control Division, Beaver, Pennsylvania. J-30303

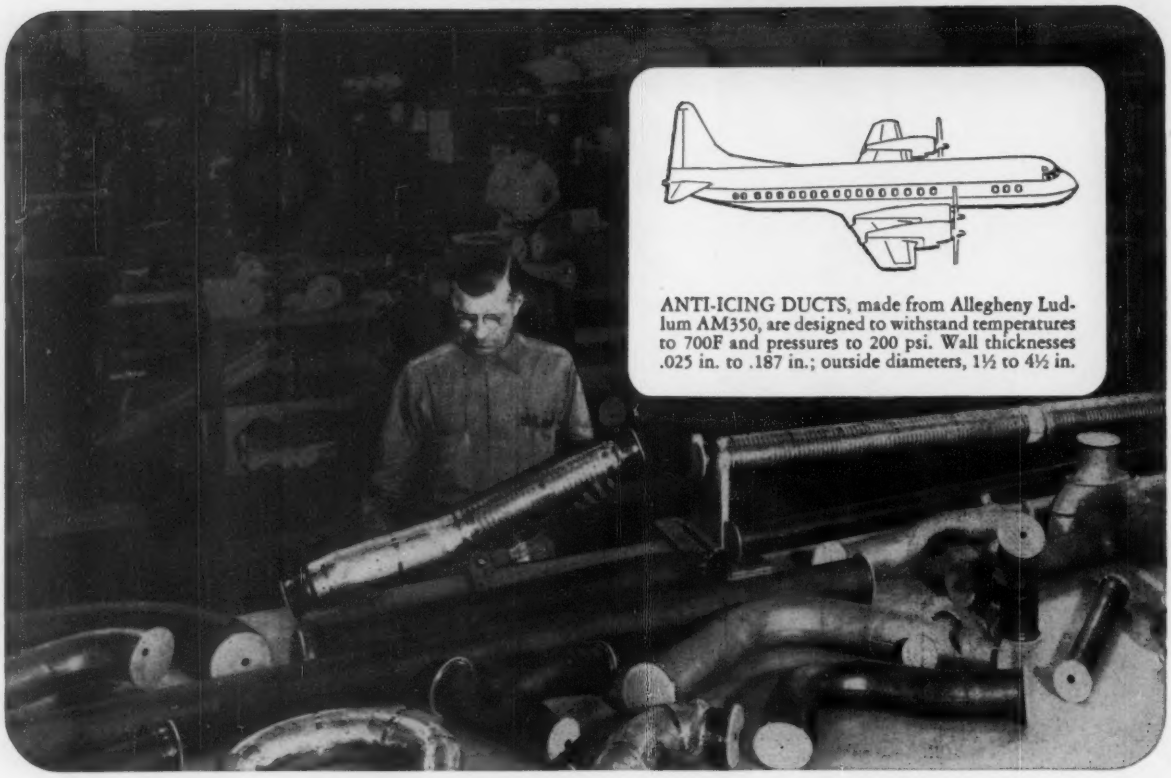
YOU CAN BE SURE...IF IT'S Westinghouse

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS." CBS TV MONDAYS

Circle 441 on Page 19



Experience**—the extra alloy in **Allegheny Stainless



ANTI-ICING DUCTS, made from Allegheny Ludlum AM350, are designed to withstand temperatures to 700F and pressures to 200 psi. Wall thicknesses .025 in. to .187 in.; outside diameters, 1½ to 4½ in.

made from Allegheny Ludlum precipitation-hardening stainless:

Prop-jet's anti-icing ducts take high heat and pressure in stride

The anti-icing system of a new prop-jet airliner was designed to operate under high heat and pressure, yet the ducting had to be as light as possible. AM350 was specified. Both AM350 and AM355, Allegheny Ludlum's precipitation-hardening stainless steels, have strength/weight ratios at 600F five times greater than the usual aluminum aircraft alloy. In fact, AM350 and AM355 maintain high strength from room temperature up to 1000F.

These space age metals have other properties highly desirable: excellent corrosion resistance, ease of fabrication, low temperature heat treatment, good resistance to stress corrosion.

These features have been used to advantage in airframe structural members, airframe skins, pressure tanks, power plant components, high pressure ducting, nacelles and other missile and supersonic aircraft applications.

availability: AM350, introduced several years ago, is available commercially in sheet, strip, foil, small bars and wire. AM355, best suited for heavier sections, is available commercially in forgings, forging billets, plates, bars and wire.

corrosion resistance: Compared to the more familiar stainless grades, AM350 and AM355 resist corrosion and oxidation better than the hardenable grades (chromium martensitic) and only slightly less than the 18 and 8's. They resist stress corrosion at much higher strength levels than do martensitic stainless grades.

simple heat treatment: High strength is developed by two methods. Both minimize oxidation and distortion problems. The usual is the Allegheny Ludlum-developed sub-zero cooling and tempering (SCT): minus 100F for 3 hrs plus 3 hrs at 850F. Alternate method is Double Aged (DA): 2 hrs at 1375F plus 2 hrs at 850F.

easy fabrication: AM350 and AM355 can be spun, drawn, formed, machined and welded using normal stainless procedures. In the hardened conditions, some forming may be done . . . 180 degree bend over a 3T radius pin. Also AM350 can be dimpled in the SCT condition to insure accurate fit-up.

For further information, see your A-L sales engineer or write for the booklet "Engineering Properties, AM350 and AM355." *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.* Address Dept. MD-12

WSW 7341

ALLEGHENY LUDLUM

EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT

AL

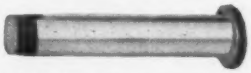
"Full-round" design of Link-Belt LXS chain avoids stress raisers

ROLLERS are accurately machined for correct operating clearances and free-rolling action.

SIDEBARS of selected steel have accurately machined "full-round" pitch holes, which maintain firm, tight press fit of pins and bushings.

FOR POWER TRANSMISSION, LXS chain is generally supplied with offset sidebars. Uniform stress distribution provides extra chain life and safe dependable operation.

FOR CONVEYING AND ELEVATING, LXS chain with straight sidebars and rollers to meet varied operating conditions. A wide variety of attachments is available.



"FULL-ROUND" PINS are made from a tough steel, specially treated for high strength in shear . . . sized for controlled press fit to prevent rotation in sidebars.

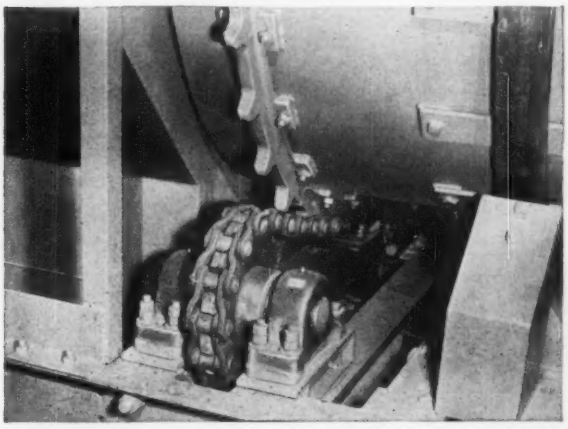
"FULL-ROUND" BUSHINGS are properly hardened to shrug off shock, resist wear . . . accurately sized for controlled press fit to prevent rotation in sidebars.

Greater live bearing area extends life

Stress concentration points are eliminated in Link-Belt LXS chain! "Full-round" design avoids sharp corners which may be the starting points of chain failure . . . provides maximum live bearing area between pin, bushing and sidebars. As a result, stress is distributed evenly . . . long chain life is assured under severe conditions.

Pins and bushings of LXS chain are accurately sized . . . assuring controlled press fits, preventing rotation in sidebars. Similar accuracy in machining of sidebars permits close control of pitch and proper chain length after assembly.

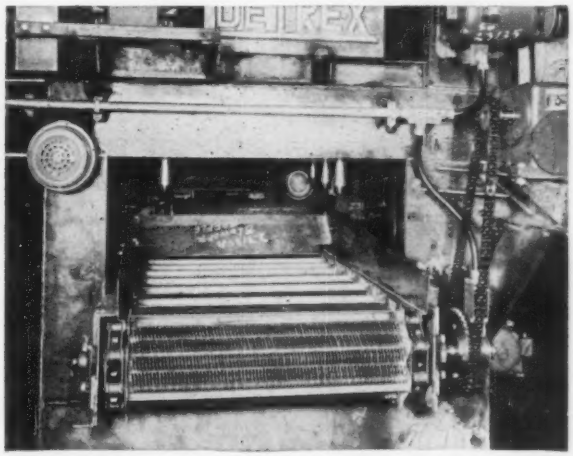
Other long-life features of Link-Belt LXS chain include use of selected steels and controlled hardening of all parts. Both contribute to greater endurance . . . greater uniformity.



LXS drives stand up to impact and abrasive service

Large, live bearing area makes LXS chain ideal for exposed drives and abrasive conditions such as found on this heavy rotating drum. Uniform distribution of load over ample bearing area reduces cutting action of abrasives . . . extends chain life.

LXS chain has stamina required for long, heavy-duty conveyors



With its exceptional strength and wear resistance, Link-Belt LXS chain can easily meet rugged conveying and elevating requirements. Due to accuracy of pitch and attachment spacing, plus close matching of multiple strands, LXS has the added strength and wear life necessary for the extra-long conveyors so important to today's highly mechanized industry.

HEADQUARTERS for chains, sprockets and other Link-Belt conveying and mechanical power transmission products is your nearby Link-Belt office.

LINK-BELT

THE SYMBOL OF QUALITY — LB — LINK-BELT

CHAINS AND SPROCKETS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,741

WHAT MATERIAL

SEEBURG STEREOPHONIC PHONOGRAPH

IS ALWAYS NEW?

BAKELITE
BRAND
PLASTICS

...offering new freedom in design...and cost... and functional advantages!

It continually appears in *new* compounds and forms to meet new specifications.

It encourages the creative talents of design engineers, architects and interior and industrial designers.

You *know* the answer—BAKELITE Brand Plastics.

And BAKELITE Brand Plastics almost invariably offer cost, production, and functional advantages *as a plus!*

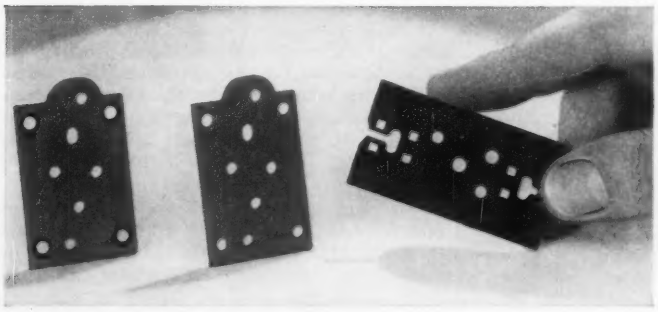
An example of the improvements in design made possible by BAKELITE Brand Plastics is shown at left. It is the first electronic brain, or memory unit, for music machines and jukeboxes. This assembly replaces the old electro-mechanical relay system of record selection and programming, which had moving parts that could wear out or fail.

Whatever your design area, no matter how unusual the qualities you require for forming, strength, rigidity, flexibility, insulation, corrosion resistance—explore the proven advantages of BAKELITE Brand Plastics and Resins. The material that's new all the time!

Technical representatives with years of training and field experience are available to discuss your special design problems. Write Dept. LW-52D.

BAKELITE Brand Polystyrene was chosen to encase this domestic food waste disposer...another example of a plastic meeting **exact** specifications. Ease of molding was required for the graceful design, along with chemical inertness, resistance to heat, attractive color and luster, durability and high impact strength. Molded of BAKELITE Brand TMDB-5161 for Waste King Corp., Los Angeles, by Modern Plastic Co., Los Angeles, and Industrial Molding Corp., Culver City, Calif.

* * *

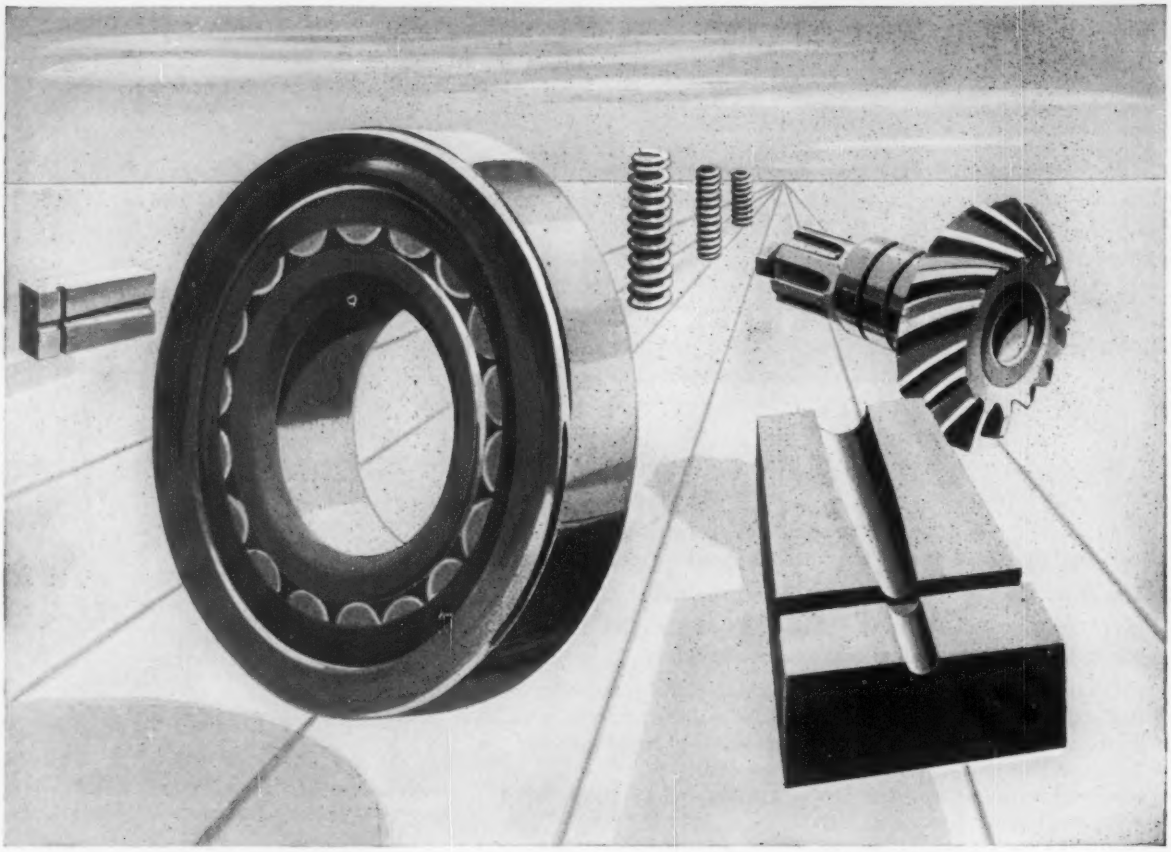


BEARING PLATES and TERMINAL BOARDS of "BAKELITE" Brand Phenolic are important components in the new automatic memory unit shown on the left-hand page. Using miniature toroid cores made of powdered ferrite material, operation is similar to that of giant electronic brains. BAKELITE Brand Phenolic was chosen for its excellent electrical insulation properties, high temperature resistance, impact strength, and dimensional stability. Developed by The Seeburg Corporation, Chicago, with parts molded by Mayfair Molded Products, Schiller Park, Ill., and stampings by Fibre Fabricators and Spaulding Fibre Company, both of Chicago.

UNION CARBIDE PLASTICS COMPANY
Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.
In Canada: Carbide Chemicals Company, Division of Union Carbide Canada Limited, Toronto 7
The terms BAKELITE and UNION CARBIDE are registered trade-marks of UCC.

BAKELITE COMPANY
has a new name...
UNION CARBIDE PLASTICS COMPANY
DIVISION OF UNION CARBIDE CORPORATION

Circle 444 on Page 19



Vacuum-melted alloys make parts stronger . . . give them operational dependability and longer life. Can a General Electric vacuum-melted alloy solve a design problem for you?

General Electric vacuum-melted alloys open vast new areas for mechanical design

G-E alloys have remarkably improved mechanical properties . . . are consistently pure and easier to fabricate

Notable advances in the design of aircraft propulsive systems have already been made possible by the development of vacuum-melted metals by the General Electric Company. And these better alloys can now make radical designs feasible in other mechanical fields.

Melting metals in a near-perfect vacuum makes them cleaner, essentially free from inclusions, impurities, gases, and oxides. Entirely new metals can be alloyed that could not even be made by air melting methods.

These superior properties of G-E vacuum-melted alloys include improved ductility, making otherwise unworkable metals easy to forge, weld or form; more uniform properties, giving operational reliability to machine components; and superior fatigue properties to give springs and diaphragms longer service life and consistent performance at high temperatures and stresses. And vacuum melting permits improvement in corrosion and oxidation resistant alloys because larger quantities of reactive metals can be used than is possible with air melting techniques.

General Electric vacuum-melted alloys can now be designed and produced to exacting specifications with consistently predictable properties and dependable life. You can order them in sheets, bars, billets and forgings.

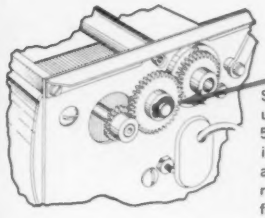
Our metallurgical engineers are ready to help you select – or design – vacuum-melted alloys to meet your specifications. For more information – or the assistance of a G-E engineer – call or write: *Metallurgical Products Department of General Electric Company, 11159 E. 8 Mile Ave., Detroit 32, Michigan.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

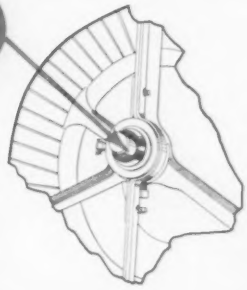
Truarc Rings Eliminate Parts and Machining, Speed Assembly, Reduce Manufacturing Costs

Ring eliminates nut and threading, saves $365/M



Sanborn Co., Waltham, Mass., uses a Waldes Truarc Series 5555 Grip ring* to secure the idler gear assembly of its portable electrocardiograph. The ring assures faultless gear performance necessary for diagnostic accuracy, eliminates a nut and threading operation for savings of $365 per 1000 units.

Ring saves parts, speeds assembly for savings of $260/M

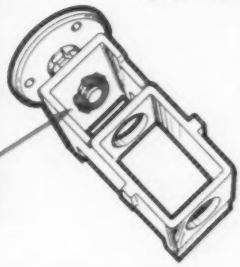


Fraser and Johnston Co., San Francisco, Calif., uses a Series 5555 Grip ring* to secure the fan shaft and speed assembly of its furnace blowers. The ring eliminates a collar and set screw for savings of $180/M on materials, $80/M on assembly time—a total of $260 per 1000 units.

2 standard rings replace 4 special parts, save $170/M

Sanymetal Products Co., Inc., Cleveland, O., uses a Series 5005 Self-locking ring and a Series 5103 Crescent® ring* to hold the escutcheon plate and handle of this doorlatch for toilet compartments. The two standard rings replace four expensive chrome-plated brass parts for savings of $170 per 1000 units.

Ring replaces spring and washer; speeds assembly 50%, saves $15/M



Allen-Bradley Co., Milwaukee, Wisc., uses a Series 5139 Prong-Lock ring* to secure the adjustment knob of its pneumatic timer. Ring eliminates a costly coil spring and washer, simplifies a tough assembly operation. Cost saving: $15 per 1000 units. Assembly time saving: 50%.

Whatever you make, there's a Waldes Truarc Ring designed to save you material, machining and labor costs, and to improve the functioning of your product.

In Truarc, you get:

Statistically Controlled Quality from raw materials to the finished product. Every step in manufacture watched and checked in Waldes' own modern plant.

Complete Selection: 36 functionally different types. As many as 97 standard sizes within a ring type. 5 metal specifications and 14 different finishes. All types available quickly from leading OEM distributors in 90 stocking points throughout the U. S. and Canada.

Field Engineering Service: More than 30 engineering minded factory representatives and 700 field men are at your call.

Design and Engineering Service not only helps you select the proper type of ring for your purpose, but also helps you use it most efficiently. Send us your blueprints today .. let our Truarc engineers help you solve design, assembly and production problems . . . without obligation. E-2

WALDES

TRUARC®

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, N. Y.

Consult the Yellow Pages of your Telephone Directory for name of Local Truarc Factory Representative and Authorized Distributor. Look under "Retaining Rings" or "Rings, Retaining."

Waldes Kohinoor, Inc., Long Island City 1, N. Y.

Please send me your new 24-page Catalog No. RR 10-58 with descriptions and illustrations of the complete line of Truarc retaining rings, pliers and accessory tools and 80 typical applications.

(please print)

Name_____

Title_____

Company_____

Business Address_____

City_____ Zone_____ State_____

MD-120

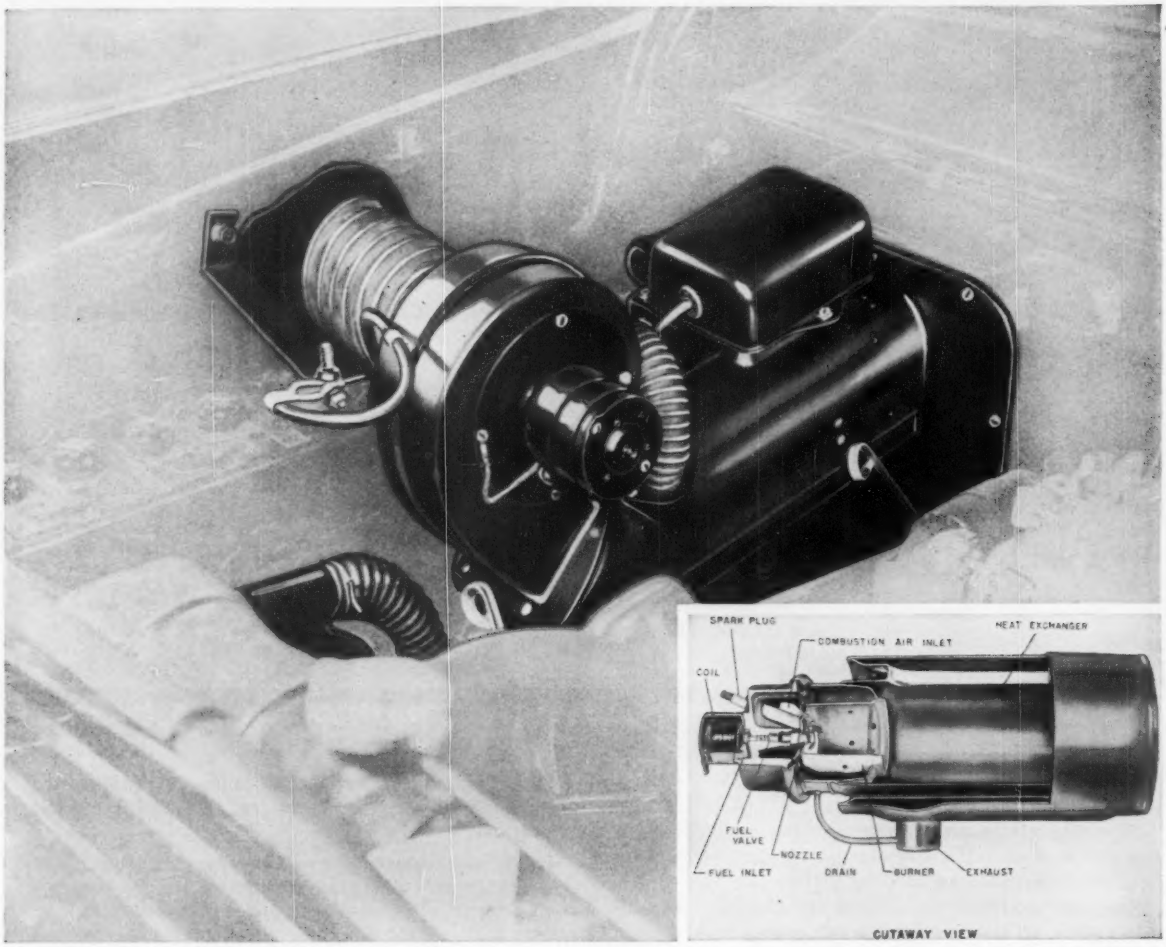
©1958 Waldes Kohinoor, Inc.

*Covered by one or more of the following patents: Nos. 2,382,948; 2,491,306; 2,574,034; 2,755,698.

Circle 446 on Page 19

Problem-Solving Products from Republic

RESIST HEAT AND CORROSION, INCREASE STRENGTH/WEIGHT RATIOS



CORROSION AND HEAT PROBLEMS were solved in this car heater with the help of Republic ENDURO® Stainless Steel. The gasoline burning heater is manufactured by South Wind Division of Stewart-Warner Corporation, Indianapolis, Indiana.

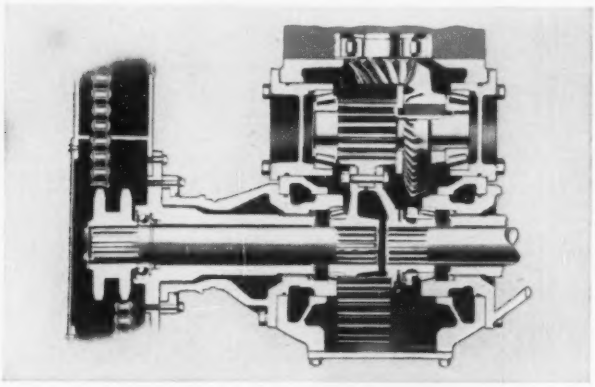
The unit is equipped with its own spark plug and fuel pump which ties into the car's gas line just ahead of the regular fuel pump. The spark plug ignites the gasoline which burns with a continuous flame for regulated periods of time. Thermostatically controlled and rated at 30,000 BTU's, the heater will deliver warm air in five seconds and 180° temperatures in 30 seconds.

ENDURO Stainless Steel, Type 430, was selected for the combustion chamber and surrounding housing because of its low thermal expansion and resistance to corrosion and oxidation at high temperatures (up to 1400°F).

Still another advantage of ENDURO, Type 430, is that it can be readily formed into desired shapes by rolling, bending, pressing, drawing, etc. Its properly prepared surface shows good resistance to atmospheric attack and tarnishing which accounts for its widespread use as molding and decorative trim sections.

Type 430 is but one of more than 35 standard types of stainless steel produced by Republic. Our metallurgists and engineers are always available to work with you in selection, application and processing. Just mail the coupon. There is no obligation.

FOR MAXIMUM SUPPORT, National Seating Company uses Republic ELECTRUNITE® Mechanical Tubing in their "cradle recline" passenger seats. The seat is mounted on 1" O.D. square ELECTRUNITE, bent to a 45° angle for styling. High ductility and superior strength-to-weight ratio of ELECTRUNITE make this operation possible. Rear legs are of ½" x 14-gage round tubing. Besides structural and ornamental advantages, steel tubing eliminates the danger of accidents caused by sharp-edged structural members. Send coupon for complete details on ELECTRUNITE.



OUTSTANDING CORROSION-RESISTANCE even after deep-drawing is provided by Republic Continuous Galvanized Steel. Under the toughest manufacturing conditions the zinc coating will not crack, flake or peel in any forming operation permitted by the base metal. That's why Mackenzie Muffler Company, Inc. uses it in fabricating mufflers for cars, trucks and tractors. Republic Continuous Galvanized cuts manufacturing costs, too. It eliminates costly hot dip operations. Permits continuous uninterrupted production. Available in a wide range of sizes, gages and grades in sheets or coils. Mail the coupon for complete facts.

EXCEPTIONALLY HIGH STRENGTH-TO-WEIGHT RATIOS plus resistance to fatigue, stress, shock and impact are values of Republic Alloy Steels that equipment builders have been relying on for years. Engineers and metallurgists of the Adams Division, LeTourneau-Westinghouse Company, for example, spent thousands of hours on research and testing of all types of steels to find one that would reduce ultimate fatigue to an absolute minimum in the drive axle of their "660" Motor Grader. They selected Republic Hot Rolled 4340 Alloy Steel. This fine steel not only resists fatigue, but also is able to take high torque without a permanent set. Specify Republic Alloy Steels where strength and toughness must resist heavy-duty roughness. Our metallurgists will help you.

REPUBLIC STEEL

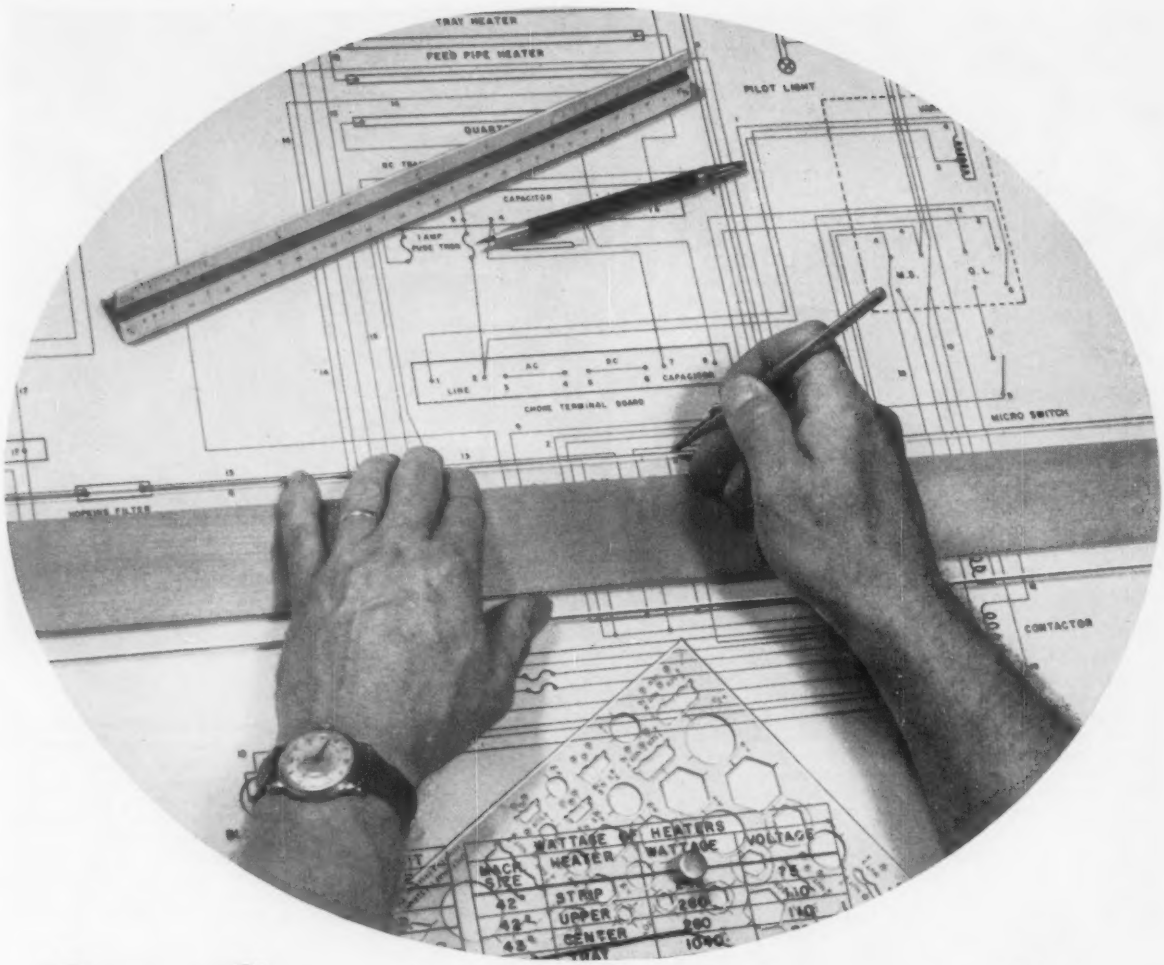
World's Widest Range of Standard Steels and Steel Products

REPUBLIC STEEL CORPORATION
DEPT. MD-5124-R
1441 REPUBLIC BUILDING • CLEVELAND 1, OHIO

Have a metallurgist call: ☐ Stainless ☐ Alloy
Send more information on:
☐ ENDURO Stainless Steel
☐ ELECTRUNITE Mechanical Tubing
☐ Continuous Galvanized Steel ☐ Alloy Steels

Name_____ Title_____
Company_____
Address_____
City_____ Zone____ State_____

Circle 447 on Page 19



Cronaflex –best drafting surface

TRADEMARK

Matted on both sides, accepts pencil and ink, erases easily

The matte surface of CRONAFLEX Engineering Reproduction Films has been designed specifically for drafting. Additions and changes can be made on these "second originals" with remarkable ease. The abrasive action is balanced to give sufficient "tooth" for all standard grades of pencils and conventional drawing India or acetate inks. Lines drawn on CRONAFLEX are sharp, not ragged.

Pencil or ink lines may be removed by erasure or with moist swabs. Photographic lines can be removed with commercial eradicators, then redrawn *on either side of the film.*

CRONAFLEX "second originals" made from your drawings are durable. They can be used to make literally hundreds of copies on direct reproduction machines. These intermediates will not print kink marks and will withstand high temperatures.

* * *

For more information on this new line, ask your Du Pont Technical Representative, or write: E. I. du Pont de Nemours & Co. (Inc.), Photo Products Department, Wilmington 98, Delaware. In Canada: Du Pont Company of Canada (1956) Limited, Toronto.

This advertisement was prepared exclusively by Phototypography

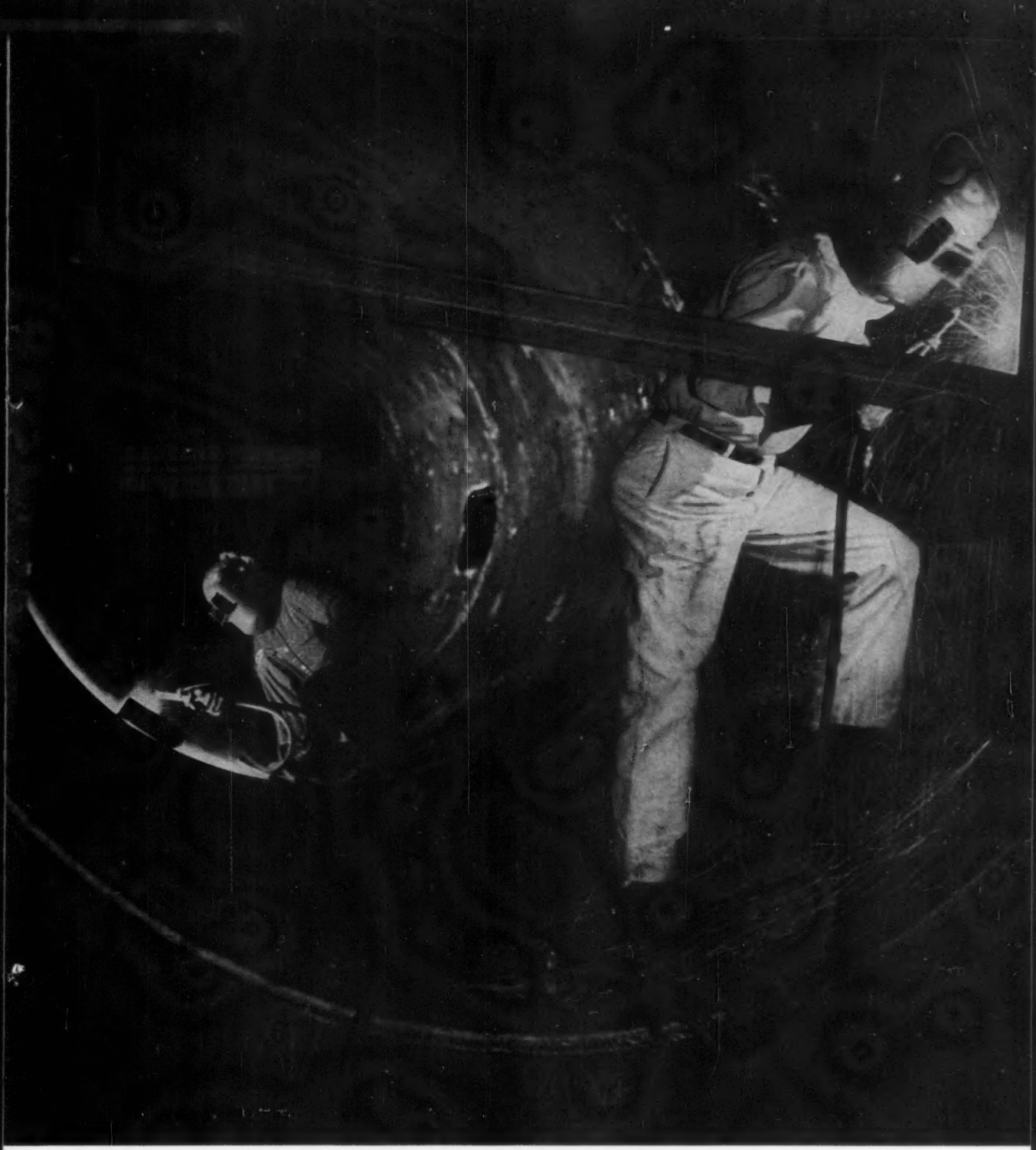
DU PONT

REG. U. S. PAT. OFF.

Better Things for Better Living . . . *through Chemistry*

Circle 448 on Page 19

Circle 449 on Page 19→



Claymont's new Fabrications Shop is completely equipped to produce large industrial and structural weldments, as well as job-shop steel plate fabrications of all kinds. Integrated facilities make Claymont a reliable source of quality steel plate and plate products for industry.

by d'Arazien

CLAYMONT
FABRICATED STEEL PRODUCTS

CF&I

CHECK CLAYMONT FOR—Alloy Steel Plates • Carbon Steel Plates • Stainless-Clad Steel Plates High Strength Low Alloy Steel Plates • CF&I Lectro-Clad Nickel Plated Steel Plates • Pressed and Spun Steel Heads • Manhole Fittings and Covers • Fabricated Steel Products Large Diameter Welded Steel Pipe

PRODUCTS OF WICKWIRE SPENCER STEEL DIVISION • THE COLORADO FUEL AND IRON CORPORATION

Plant at Claymont, Delaware • Sales Offices in all Key Cities

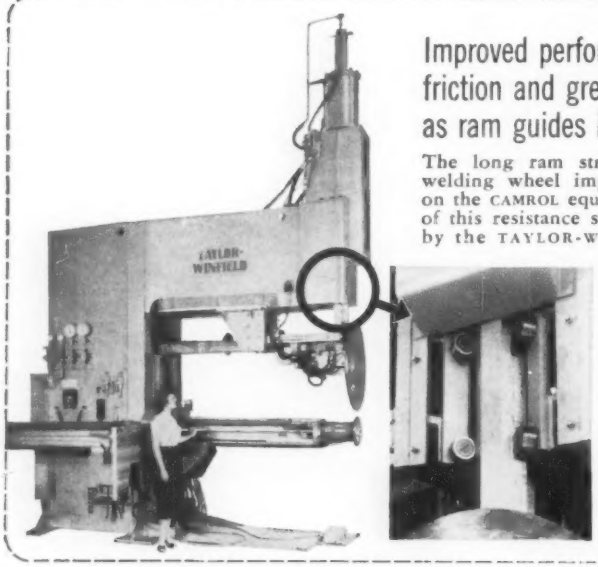
5743

BEARING TIPS
by McGill

McGILL CAMROL® bearings cost less to increase efficiency of cam follower, guide and support roller applications

Using CAMROL CF and CYR (cam yoke roller) bearings eliminates the inconvenience of obtaining and processing component parts for built up followers. It costs less to select the proper size CAMROL bearing from stock than machine and assemble loose bolts, bushings, bearings, and snap rings.

CAMROL bearings are engineered and precision built to carry heavier loads with greater accuracy and alignment. An extra heavy outer race with full roller complement on a flanged stud (or inner for CYR) offers high load and shock capacity. Smooth, dependable action with low starting friction is assured through longer machine life. Available sealed also.



Improved performance, reduced friction and greater accuracy as ram guides in huge welder

The long ram stroke and large diameter welding wheel impose severe requirements on the CAMROL equipped ram guiding device of this resistance seam welder manufactured by the TAYLOR-WINFIELD CORPORATION.

The CAMROLS provide greater accuracy with less friction than was experienced with a round ram and bushing type bearing formerly used. Lubrication is simplified, maintenance reduced and performance is excellent.

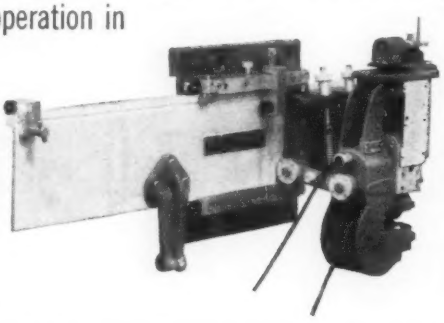
The welder has a throat depth of 84" and a 12" vertical stroke of the upper ram carrying the large diameter welding wheel.

CAMROL® bearings take severe impact loads in hydraulic snubbing hooks

CAMROL CF bearings are used as hook positioner rollers in BYRON JACKSON HYDRAPLEX HOOKS. These heavy-duty (100-150 ton capacities) hooks are used in oil well drilling work. The hook positioner mechanism includes CAMROL cam followers that travel on a hardened cam track when the load is released to return the hook to its original position. The CAMROL bearings take severe impact loads in the thousands of pounds.

Ease of assembly and smooth operation in electrolimit continuous gage

PRATT & WHITNEY CO., INC., manufacturers of the ELECTROLIMIT CONTINUOUS GAGE shown here have cut costs through the elimination of built up followers requiring ball bearings, shafts, spacers and milling slots by using sealed CAMROL bearings. They are prelubricated and protected. The CAMROL bearings which travel along a vertical cross slide rail, provide smooth, easy action as the gage slides onto strip material running through the mill. No bearing replacement reported in over 10 years.



engineered electrical products

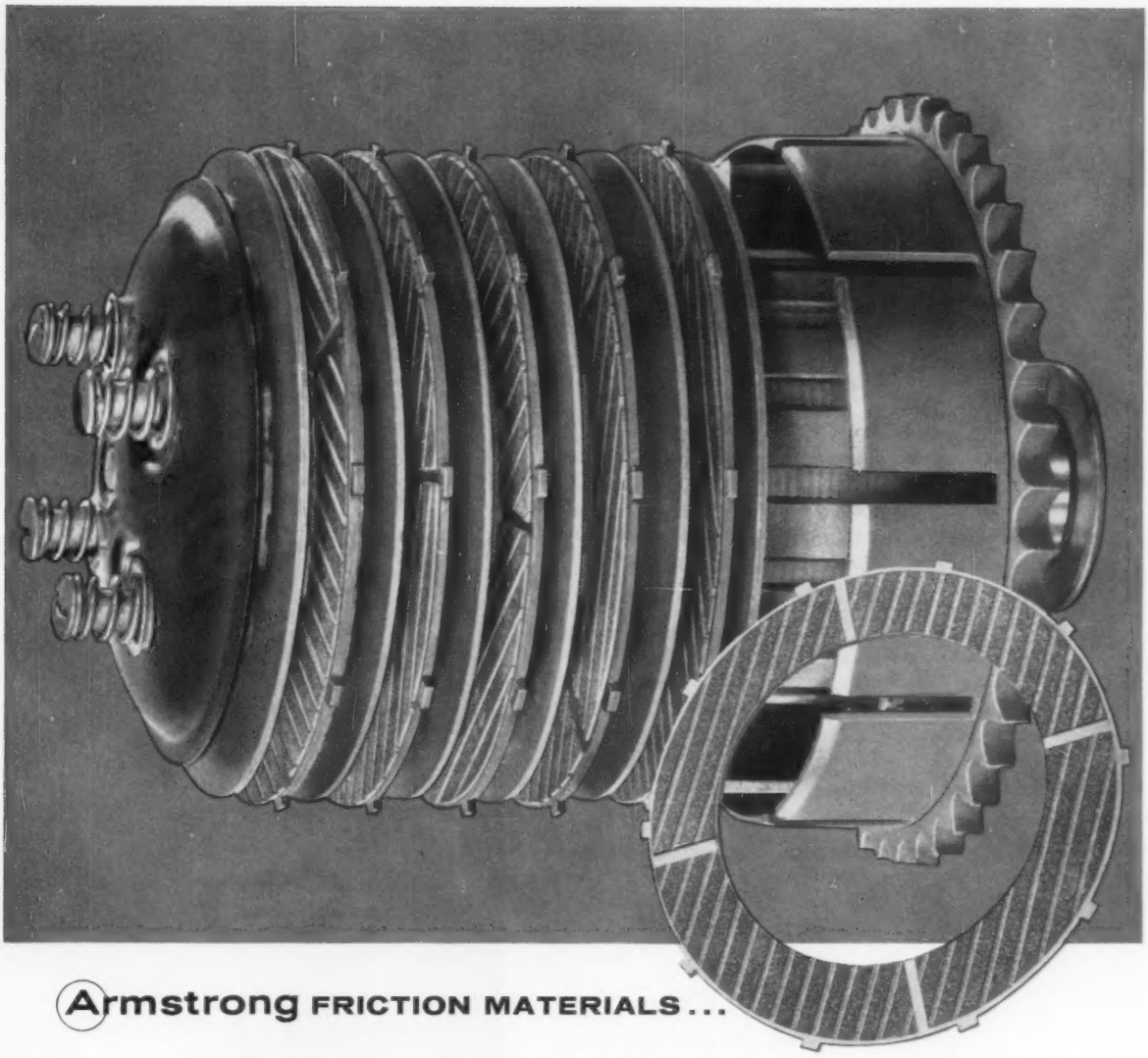
McGILL®

precision needle roller bearings

SEND FOR CATALOG No. 52-A

MULTIROL — GUIDEROL — CAMROL

McGILL MANUFACTURING COMPANY, INC., BEARING DIV., 200 N. LAFAYETTE ST., VALPARAISO, INDIANA



Armstrong FRICTION MATERIALS . . .

eliminate clutch failure under severe operating conditions

Road races and cross-country endurance runs are severe tests for all the components of a motorcycle and particularly for the clutch facings.

The Triumph motorcycle clutch shown above has to engage quickly at speed differentials as high as 4,000 rpm, at full throttle, as many as 20 times a minute. At top speed, the motor develops 45 to 50 hp. The clutch plates are splash lubricated with oil at ambient temperatures of 250° F.

In testing materials to find one that could stand up under these conditions, Triumph engineers selected Armstrong NC-733. This cork-rubber facing engaged almost instantaneously, even when soaked with oil, reducing the heat generated by excessive slippage. A faster engagement also gave Triumph a competitive speed advantage by cutting seconds off shifting time.

By making Armstrong NC-733 the standard material for all heavy-duty clutches, Triumph has now eliminated burned facings and resulting clutch failure.

Whatever your application for resilient friction materials, you'll find the right facing for your requirements among the many in the Armstrong line.

Send for informative booklet

A new booklet describing our full line of resilient facings has just been published. Write today for your copy of "Armstrong Resilient Friction Materials." Armstrong Cork Company, Industrial Division, 7212 Dean Street, Lancaster, Pennsylvania.

Armstrong RESILIENT FRICTION MATERIALS

. . . used wherever performance counts

Memo on Metals

New Age-hardenable Titanium Alloys Offer Up to 220,000 psi Tensile Strength and Easier Formability for 600 to 1,000 F Applications

Three new age-hardenable titanium alloys may prove to be the solution to many of the strength-weight and temperature problems encountered in designing advanced aircraft and missiles. They may also prove extremely economical for such applications.

All three offer much higher strengths than other titanium alloys – and have the light weight and corrosion resistance typical of titanium alloys. Furthermore, they are readily FORMAGEABLE* – capable of being formed in the solution-treated or "soft" condition and then strengthened by simple thermal aging techniques. Each is now in pilot production and available in limited quantities of mill products.

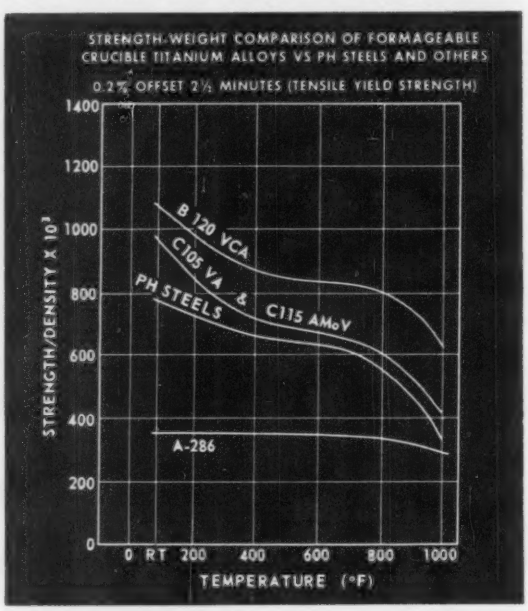
First Age-hardenable All-beta Ti Alloy

Crucible B-120VCA is the first useful titanium alloy with an all-beta (high temperature) structure. It has both the highest strength and best formability of any titanium-base alloy.

This alloy's composition (13%V-11%Cr-3%Al) enables its structure to stay all-beta during forming and/or during slow cooling, and to age to high strength levels at temperatures where distortion is not a problem.

B-120VCA has a unique combination of properties. Room temperature strengths of 200,000 to 250,000 psi have been obtained. On a strength-weight basis this is the highest strength of any available structural material. In short-time elevated temperature tensile tests (1-2 minutes), it offers a decided strength-weight advantage over alternate materials at temperatures up to at least 1,000 F. Under creep conditions, for very long periods of time, it enjoys a strength-weight advantage up to at least 600 F. Beyond this limit, the other Crucible FORMAGEABLE titanium alloys are recommended.

B-120VCA is ductile-weldable, cold-headable, and has great and deep hardenability. Because of this formability, it should prove suitable for applications such as aircraft skins, stiffeners and other primary structural shapes, and for missile pressure tanks, rocket motor cases and structural members. Preliminary tests indicate it may prove unequalled as a construction material for honeycomb assemblies. Because it is so easy to cold-head, it has a large potential in such items as rivets.



Alpha-beta Titanium-base Alloys

Crucible C-105VA is an alph-beta titanium-base material which also is FORMAGEABLE. Its 16% vanadium content stabilizes a sufficient amount of the beta phase for good age-hardenable response; the 2.5% Al content improves the alloy's elevated temperature properties.

C-105VA resolves two conflicting requirements for aircraft sheet material. It is soft, ductile and easily formed in the solution-quenched condition. Because the formed parts can be aged subsequently at moderate temperatures, parts made of C-105VA can possess high strengths at temperatures up to 800 F for long periods of time.

* *age-hardenable titanium alloys*
* *tool steels in production parts*
* *borated stainless steels*

This third alloy, C-115 AMoV (4%Al-3%Mo-1%V), also shows considerable promise for aircraft sheet applications. It is age-hardenable to higher strengths than C-105VA with only slight sacrifice in forming characteristics.

Considerable data on the properties and fabricating qualities of all three alloys have been assembled by Crucible's Titanium Division. For data sheets and additional information, send the coupon.

Tool Steels Replace Standard Alloys for Production Parts

As design and metallurgical engineers require materials with improved properties or greater uniformity, they are turning more to the use of tool steel for production parts. Here are three good examples:

1. Vanes in the hydraulic system that actuates the automatic steering mechanism on cars are made of Crucible REX® M-2 high speed steel. REX M-2 combines the abrasion resistance necessary for minimum wear with the impact resistance needed for long life and safety. The manufacturer experimented with numerous other steels, but high speed steel lasted longer than any other type tested.

2. Actuator bars for a nationally-known calculator are now being produced of Crucible KETOS® – a low-priced AISI Type O1 alloy tool steel – because the thin, close-tolerance contact edges withstood over 4-million high speed blows in a life test. No other steel has lasted more than 1-million cycles before chipping and failing.

3. Cylinder block for a fast acting, aircraft hydraulic pump made of Crucible Chrome tool steel. Pump operates at temperatures up to 500 F, pressures to 5,000 psi. Tool steel was selected over a standard AISI alloy because of its high degree of cleanliness, uniform response to heat treatment, and controlled hardenability. Furthermore, because tool steel practices are employed in making it, the steel more consistently meets the critical mechanical and physical properties required in this application.

For data sheets on these and all other Crucible tool steels – send the coupon.

High Boron Stainless Steels Made Possible by Vacuum Melting

Type 304 stainless steel with boron has proved to be an excellent material for nuclear equipment, because the boron readily absorbs neutrons. By increasing the boron content, valuable weight and thickness reductions can be made in reactor shielding and control rods.

Unfortunately, conventionally melted borated 304 becomes "hot short" – virtually impossible to work if the boron content exceeds 1%. Vacuum melting has provided the answer to this problem. Vacuum-melted 304 stainless is readily workable when the boron content goes up to 2% or even higher.

Vacuum melting the alloy also provides closer control of the composition, because only pure materials are used. So, undesirable elements such as cobalt – which becomes radioactive upon bombardment – can be kept to a minimum. In fact, vacuum-melted Type 304 stainless can be supplied with less than .001% cobalt.

For additional information on vacuum-melted steels – send the coupon.

CRUCIBLE STEEL COMPANY OF AMERICA
Dept. EL07, The Oliver Building
Mellon Square, Pittsburgh 22, Pa.

Gentlemen:
Please send me the following:

1. Data sheets on B-120VCA ☐ C-105VA ☐ C-115AMoV ☐
2. A copy of "Titanium Alloys for Aircraft and Spacecraft" by Finlay, Vordahl and Malone ☐
3. Data Book on Crucible tool steels ☐
4. Data sheets on vacuum-melted steels ☐

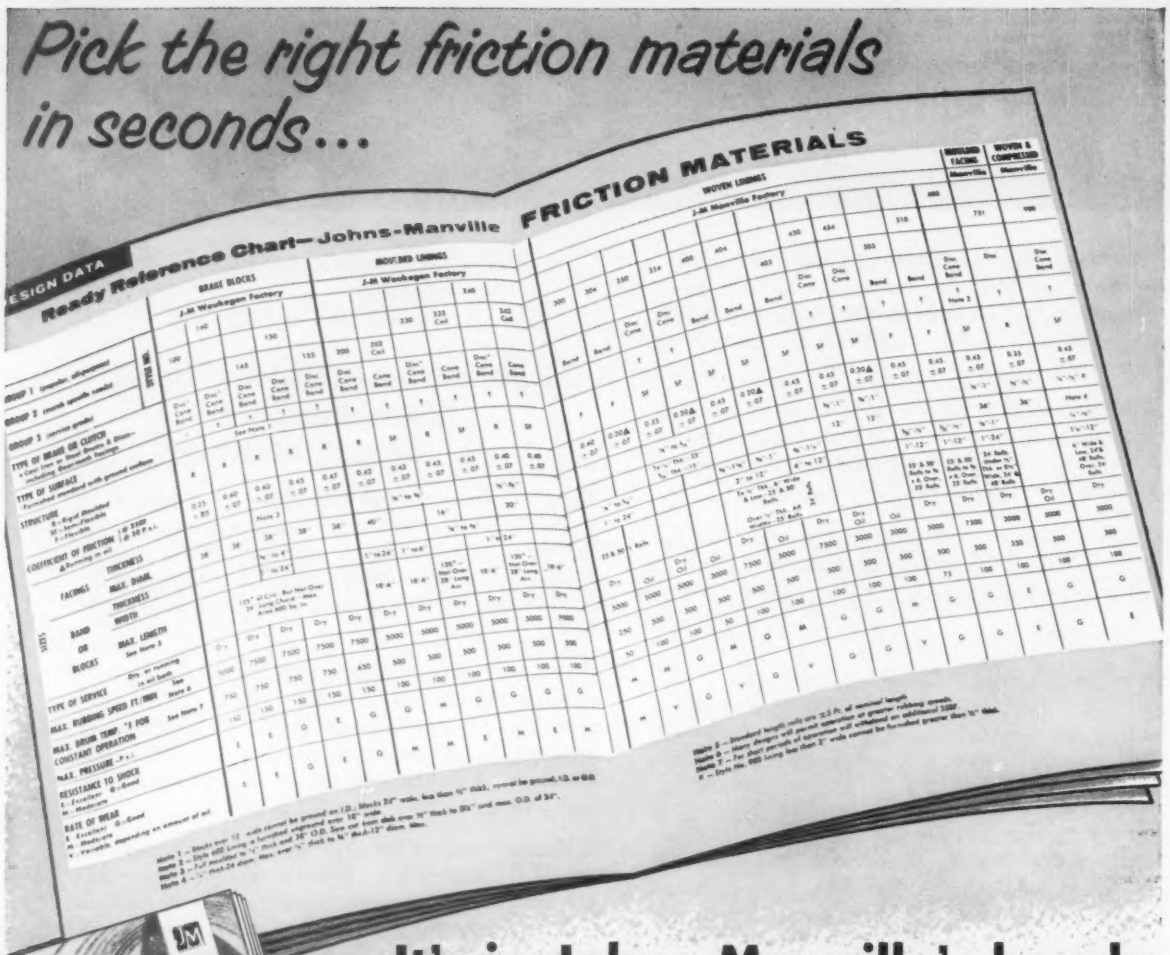
Name_____ Title_____
Company_____
Street_____
City_____ Zone_____ State_____

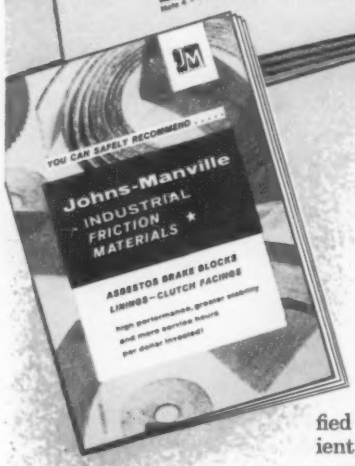
CRUCIBLE STEEL COMPANY OF AMERICA

*Reg. Trade Mark

Circle 452 on Page 19

Pick the right friction materials in seconds...





It's in Johns-Manville's handy new Friction Materials Selector

WHEN YOU ENCOUNTER a design problem that involves the control of motion, you'll find this new, ready-reference book about Johns-Manville Friction Materials a big help. Its sixteen pages are loaded with specific design data, presented in simplified table form, that you'll find convenient, accurate and easy to use.

Whether you require a disc, cone, band, block or lining—for application in wet or dry service, heavy or light duty, slow or high speed operation, light or heavy pressure—this book will give you performance characteristics, available sizes and shapes, dimension data and tolerances.

Whatever your problem dealing with the control of motion the J-M Friction Material specialist . . . backed by unmatched J-M Research facilities . . . is at your service. Write Johns-Manville, Box 14, New York 16, N.Y., for your free copy of the Friction Materials Guide—FM35A. *In Canada, Port Credit, Ont.*

JM PRODUCTS

Johns-Manville *Industrial* FRICTION MATERIALS

VICKERS® OIL HYDRAULICS

BUILT AROUND THE WORLD

THESE NAMEPLATES MEAN WORLD-WIDE AVAILABILITY OF SERVICE, PARTS AND UNITS OF CONSISTENT QUALITY

When you use Vickers hydraulics, you can send your machinery almost anywhere in the free world with assurance that consistent quality service units will be available.

Vickers manufacturing facilities, as indicated by the nameplates above, are strategically located convenient to industrial centers around the world. Vickers consistent quality and parts interchangeability are maintained through a systematic program of inspection and test by the parent organization. Any component built in one plant will be compatible with components and systems from all other plants.

These are added advantages to you when you specify Vickers hydraulics on your machinery for export or for your machinery built overseas.

FOR FURTHER INFORMATION PLEASE WRITE FOR BULLETIN 5500

VICKERS INCORPORATED
Division of Sperry Rand Corporation
INTERNATIONAL DIVISION
Administrative & Engineering Center
Detroit 32, Michigan

8045

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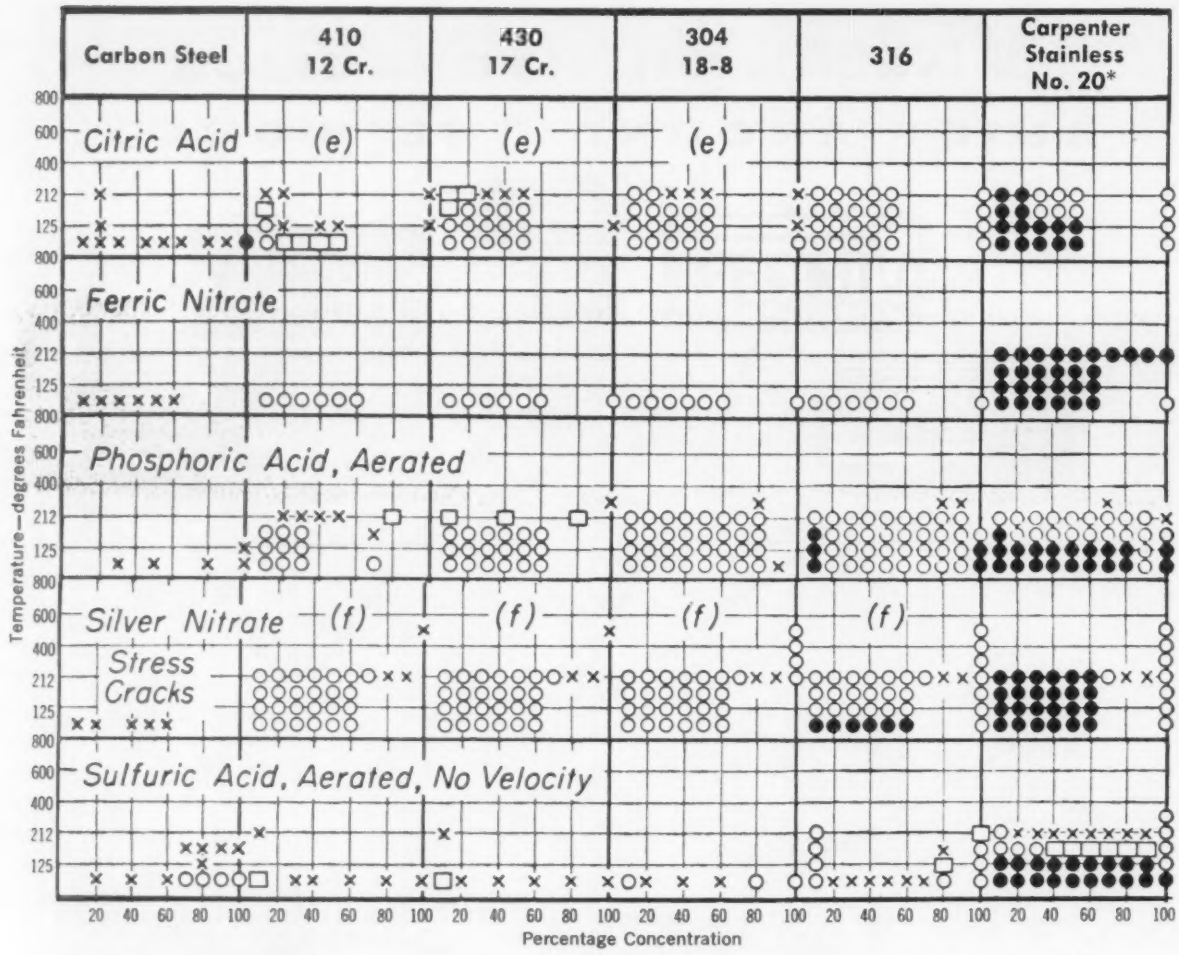


Key: ● Corrosion rate less than 2 m p y × Corrosion rate greater than 50 m p y
○ Corrosion rate less than 20 m p y (e) Avoid chlorides
□ Corrosion rate from 20 to 50 m p y (f) Acid free

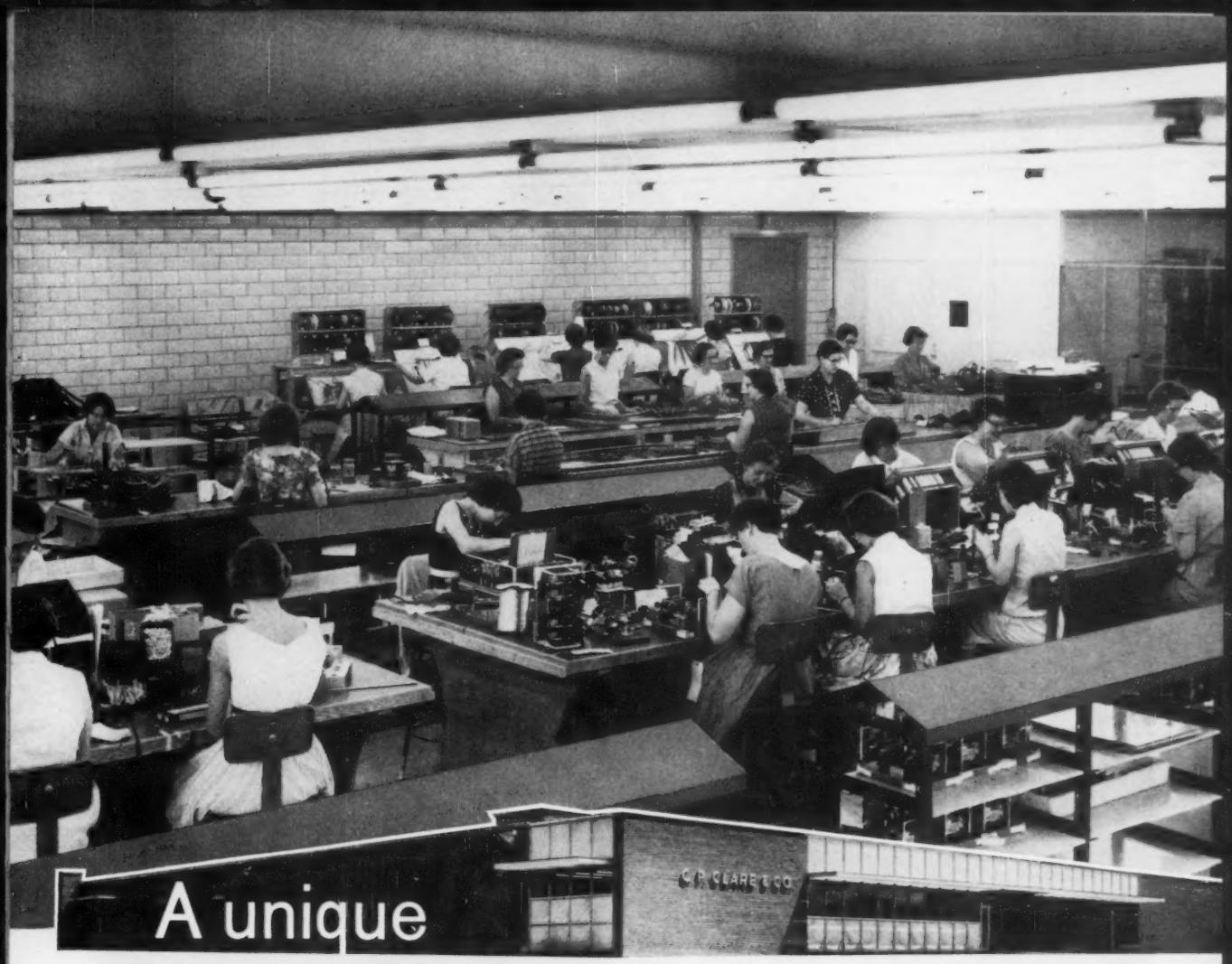
Corrosion data taken from Metals Handbook

The best single answer to most corrosion problems—*Carpenter* Stainless No. 20*

Carpenter Stainless No. 20 is your lowest cost way to control the most severe corrosive conditions. It's available in sheet, plate, bar, forging billets, forgings, tubing and pipe through your local distributor. And Carpenter Stainless No. 20 simplifies inventory problems. You don't need duplicate stocks of other products . . . one stock of Carpenter Stainless No. 20 will put an end to most corrosion problems. Order now from the "House of Corrosion Control". Complete technical data and job performance reports are yours for the asking. Write on your company letterhead to The Carpenter Steel Company, Alloy Tube Division, Union, N. J.

available through representatives and distributors in over 40 cities . . . coast to coast

Circle 455 on Page 19



CLARE Service
which can solve your Wiring Problems

If your present policy is to buy separate relays and switches and perform the necessary wiring yourself, you can benefit from our new, complete wiring service.

From the smallest bench unit to large rack-type cabinets, CLARE can offer packaged wired assemblies to meet your exact requirements. We can build to your specifications, or construct assemblies from our own stock of bases, connectors, plugs, and other components.

With the opening of our new plant in Fairview, N. C., we now have the capacity to handle any wiring project. Our experience in the care and treatment of precision relays and switches is your assurance of familiar CLARE quality. We have developed our own versatile tooling to provide an *economical* service.

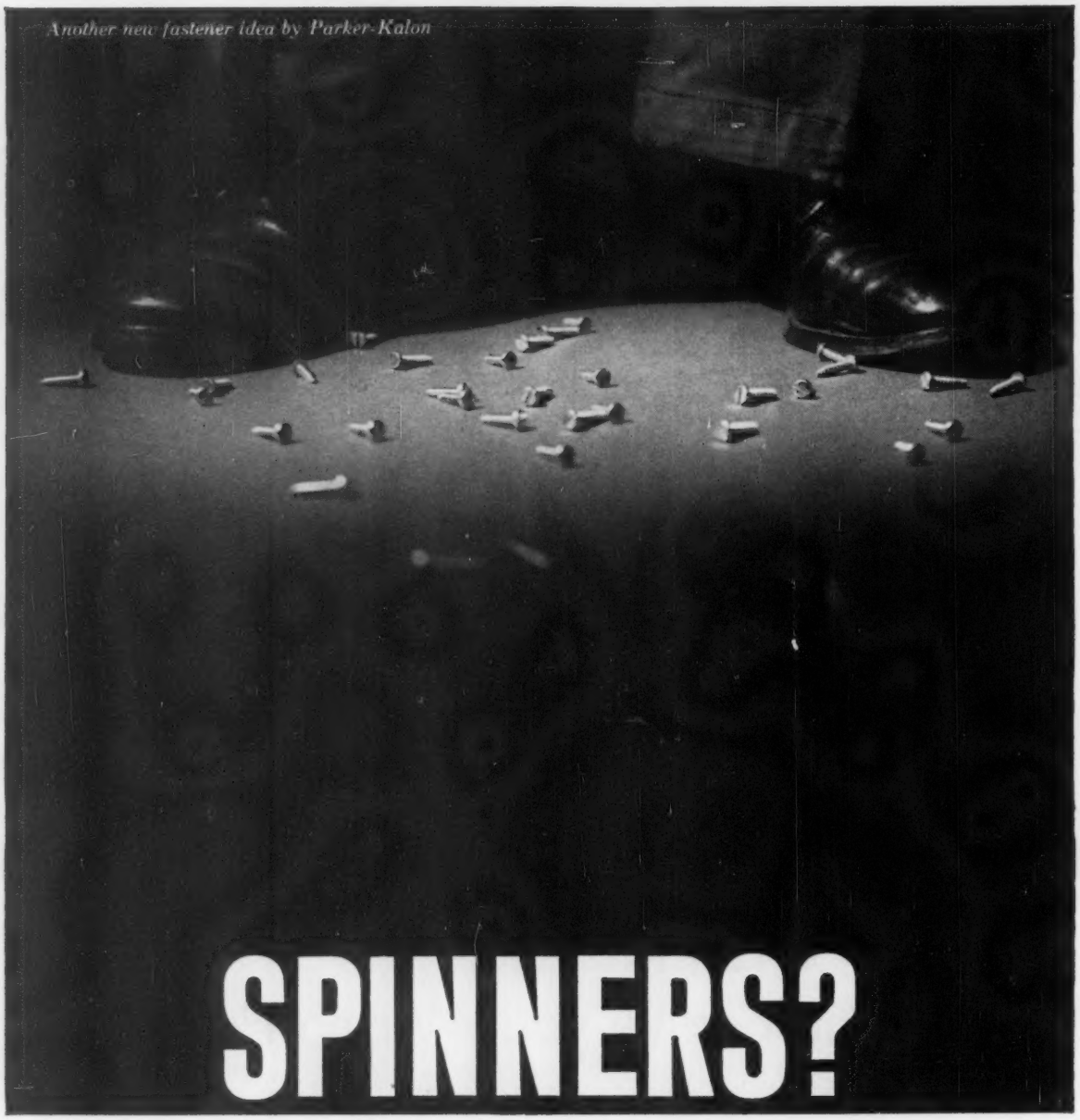
As a result, we can deliver to you wired assemblies which are fully tested and which adhere to the highest standards of quality—and we can do this *more economically* than you could do it yourself.

Why not let us show you how you can fit this special service into your own operation? Call or write: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 2700 Jane Street, Toronto 15. Cable Address: CLARELAY

CLARE RELAYS

FIRST in the industrial field

Circle 456 on Page 19



Screws on the floor mean trouble at your door! Ordinary fasteners when used in the assembly of thin gage metal sheets, often spin or slip—result in work stoppages, salvaging operations, higher production costs.

Now you can substantially reduce waste motion, rejects and lost time, with Parker-Kalon's new "*Hi-thred*" Self-tapping Screw . . . the new fastener that *grips securely without spinning or slipping* . . . even in very thin gage metal sheets.

Developed by P-K's research team, the revolutionary "*Hi-thred*" is THREADED FULL TO THE HEAD—WITH THE LAST THREAD ACTUALLY TERMINATING IN AN ANNULAR ORIFICE IN THE HEAD ITSELF!

For samples, see your nearby Industrial Distributor. "*Hi-thred*" fasteners are available in production quantities *at no increase in price* in Types "A" and "Z" in non-countersunk head styles, in either Slotted or Phillips Recessed Heads.

Keep American Industry at Work! BUY P-K MADE IN U.S.A.

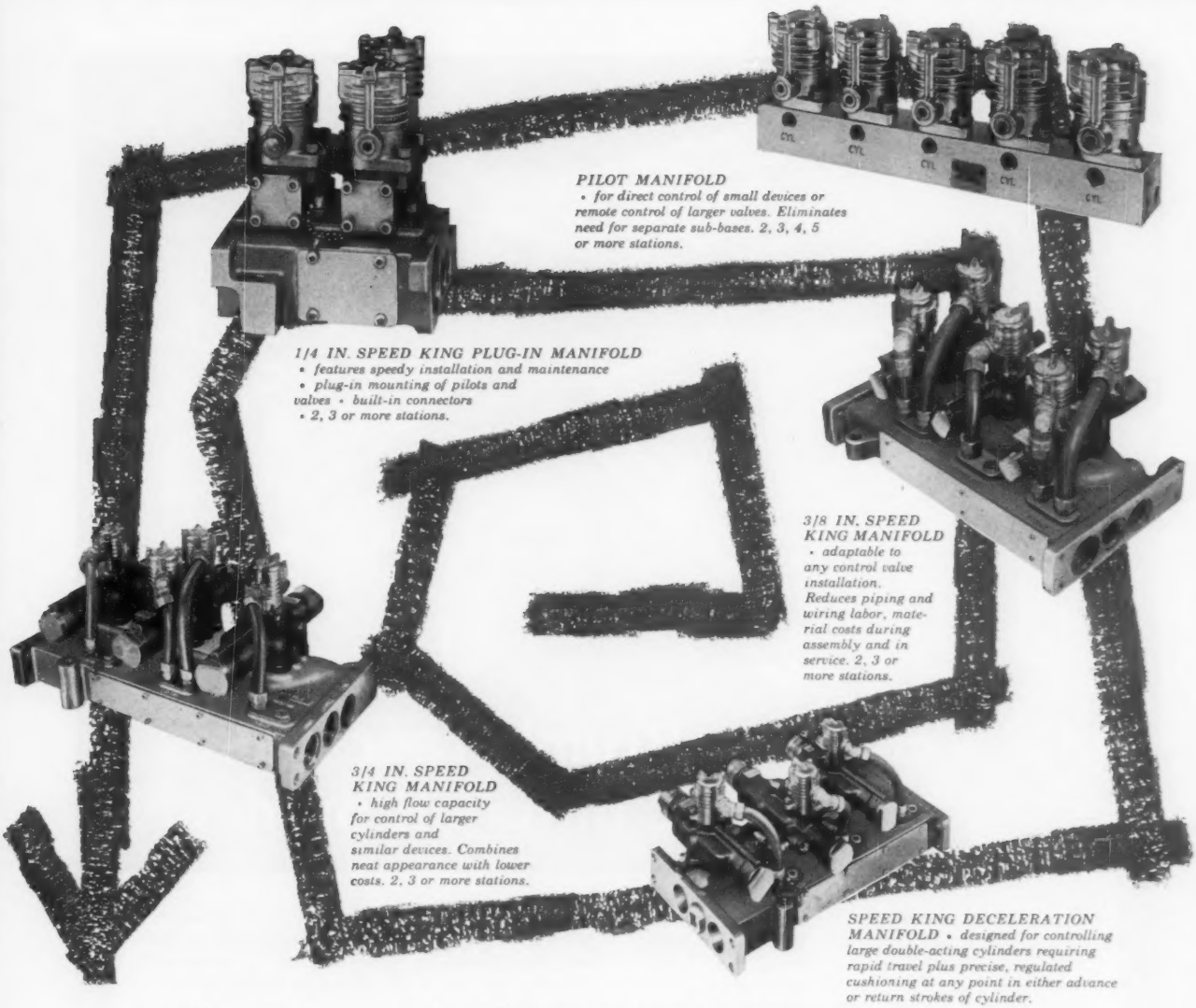
PARKER-KALON® "Hi-thred"

Pat. Pending

Self-tapping Screws

Sold everywhere through leading Industrial Supply Distributors

PARKER-KALON DIVISION, *General American Transportation Corporation, Clifton, New Jersey*


PILOT MANIFOLD
• for direct control of small devices or remote control of larger valves. Eliminates need for separate sub-bases. 2, 3, 4, 5 or more stations.
1/4 IN. SPEED KING PLUG-IN MANIFOLD
• features speedy installation and maintenance • plug-in mounting of pilots and valves • built-in connectors • 2, 3 or more stations.
3/8 IN. SPEED KING MANIFOLD
• adaptable to any control valve installation. Reduces piping and wiring labor, material costs during assembly and in service. 2, 3 or more stations.
3/4 IN. SPEED KING MANIFOLD
• high flow capacity for control of larger cylinders and similar devices. Combines neat appearance with lower costs. 2, 3 or more stations.
SPEED KING DECELERATION MANIFOLD • designed for controlling large double-acting cylinders requiring rapid travel plus precise, regulated cushioning at any point in either advance or return strokes of cylinder.

simplify piping . . . cut installation and maintenance costs . . .

use VALVAIR MANIFOLDS

. . . sizes and types for every application

Save space . . . save assembly time . . . save on piping and wiring material costs . . . improve machine appearance . . . up-grade reliability by eliminating unnecessary connections . . . specify Valvair manifold mounting for your multiple control valve installations.

Easy unit replacement speeds in-service maintenance, too . . . slashes machine down-time. Manifold sizes range from 1/4 to 1 inch NPT . . . in types and combinations *exactly* suited to your requirements. Valvair Corporation, 454 Morgan Ave., Akron 11, Ohio.

AA-8905

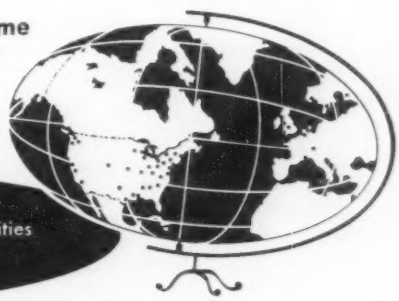
- **economical multiple mounting**
- **common inlet and exhaust ports**
- **bench wiring reduces installation time**
- **manifolds can be ganged to mount 2, 3, 4, 5, 6 or more valves**

Find us fast in the 'Yellow Pages'

Compare . . . and you'll buy

Valvair

SALES AND SERVICE FROM LOCAL STOCK

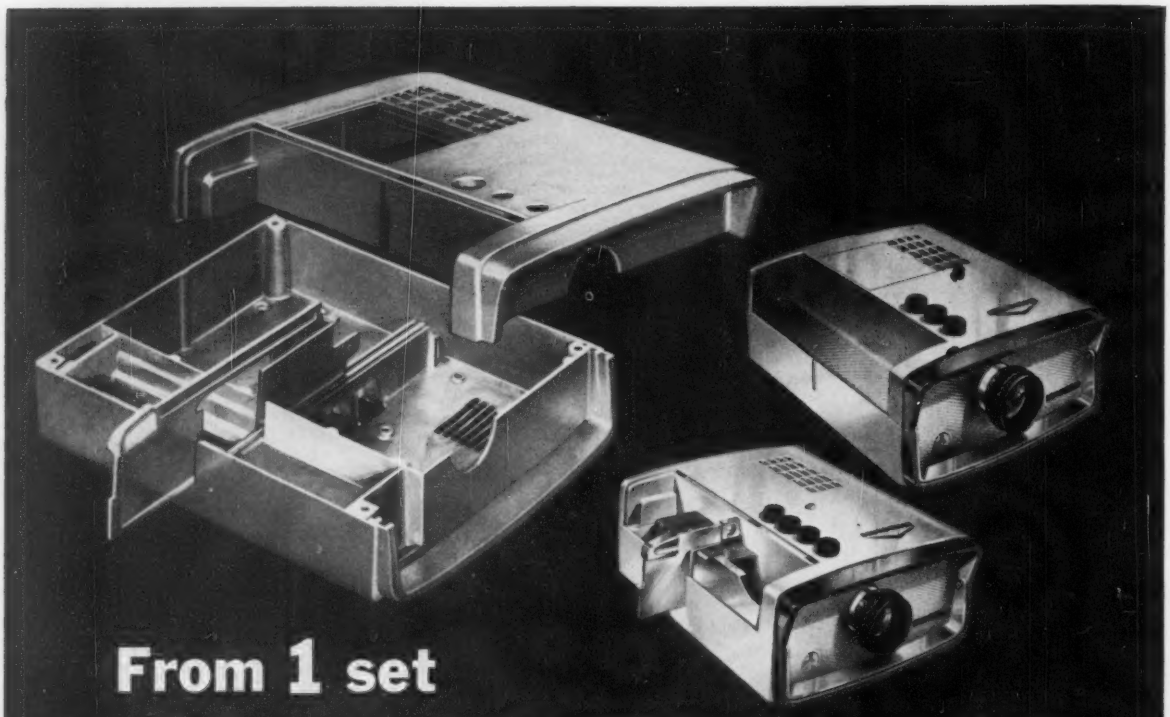


Representatives in principal cities throughout the world

DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION

Plants in Akron, Ohio; Canton, Pennsylvania; Birmingham, England; Amersfoort, Holland

Circle 458 on Page 19



From 1 set of die castings Brumberger makes 2 different products

CASE HISTORIES FROM MT. VERNON FILES

If you like to project color transparencies, these two new automatic Brumberger* 35 mm, low silhouette, slide projectors will dazzle you. They are priced much lower than other automatic projectors and eliminate the additional expense of slide magazines and extra carrying case.

These are fine examples of keen engineering perception, for all the inherent advantages of die casting have been applied with those of metal stampings and plastics to produce competitively priced photographic products of outstanding eye appeal and performance.

As you can see, these aluminum die castings are intricate. All the necessary slots, channels, pins, gratings, bosses, holes, compartments, handle holes and various recesses are incorporated into the shells so that simple, rapid assembly and minimum finishing operations of the final product result.

Heat from the projection lamp will not warp or weaken the castings, and correct alignment of the optical system is maintained at all times by the thin but rigid, lightweight sections. For Brumberger, die casting has proved to be a supremely advantageous manufacturing method.

More than that, Brumberger has made full use of Mt. Vernons' complete four-fold service: coordinated designing, die making, casting and machining facilities all under one roof in 200,000 square feet of manufacturing space.

And when you plan to make a better product at lower cost by resorting to die castings, we can also give you invaluable help. Just call in your nearest Mt. Vernon sales representative for fast service.

*Brumberger — Brooklyn, N. Y.

MT. VERNON
DIE CASTING CORP.
STAMFORD, CONNECTICUT

DIE CASTING RESEARCH FOUNDATION PARTICIPANT

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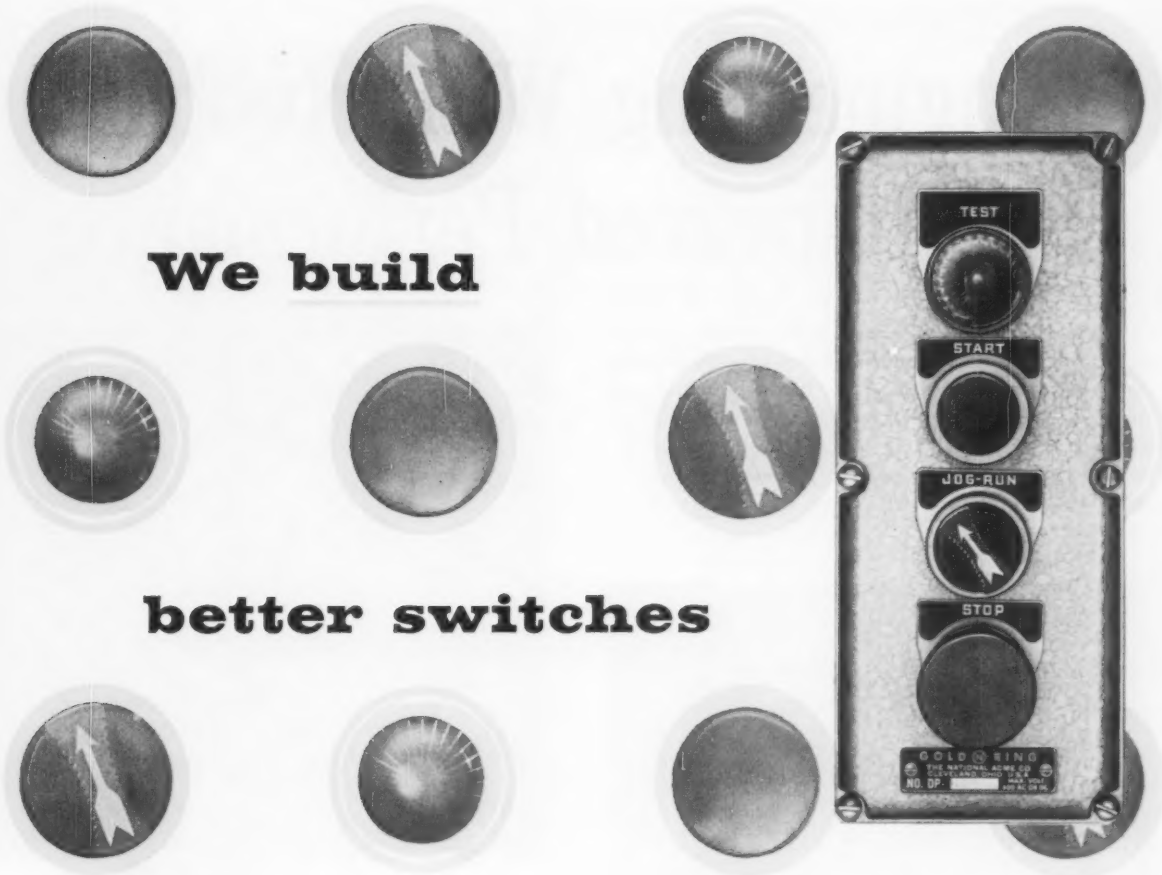
VALLEY FORGE, PA.: Mr. G. T. McMaster, P.O. Box 115

Circle 459 on Page 19



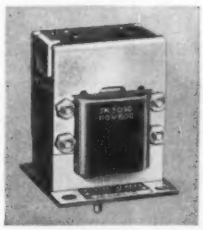
We build better switches because we can't buy them

...IT'S AS SIMPLE AS THAT...AND THEY COST NO MORE THAN OTHER SWITCHES

We had to build Gold-N-Ring Control Switches to meet our own high reliability specifications . . . our reputation was a part of this important fact. We're machine tool builders. We can't afford to be responsible for costly down-time on important capital investment equipment due to inferior control switches. That's why we build them like precise machine tools . . . and why it will pay you to check with us.

A wide range of basic units meets practically every need . . . as well as completely assembled stations in 1 to 4 button sizes to meet your electrical specifications. Ask our representative to call, or send for Bulletin ECS-56 . . . the complete selection and ordering guide.

LIMIT SWITCHES. A full line, originally designed for machine tool applications but now used wherever the highest reliability factors are required. Bulletin EM-51.



SOLENOIDS. A full line of standard and custom units for AC or DC. Push or pull types with capacities up to 25 lbs. Bulletin EM-52A.

ELECTRICAL MANUFACTURING DIVISION

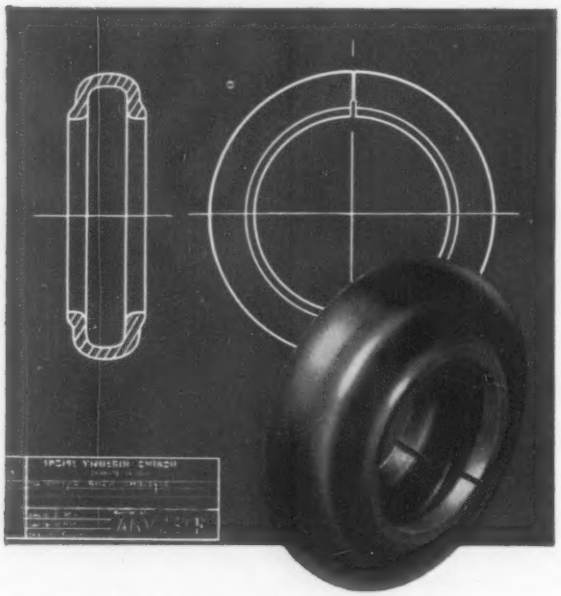
THE NATIONAL
ACME COMPANY
188 E. 131st STREET
CLEVELAND 8, OHIO

National Acme

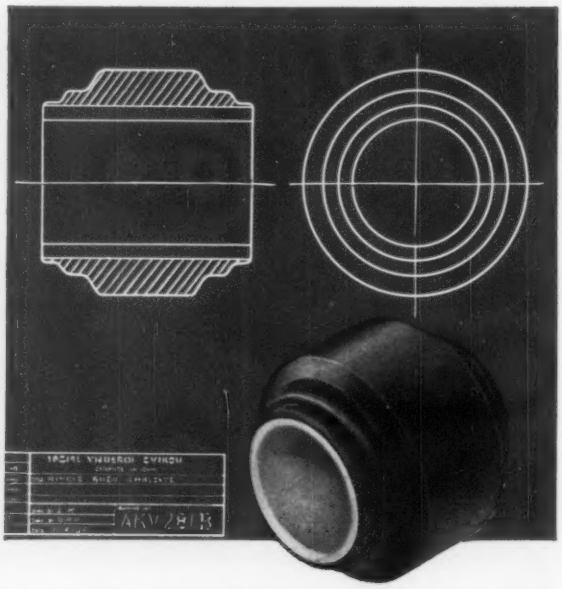
Circle 460 on Page 19

Engineering With Rubber For Improved Performance

These examples show how Dayton molded product engineers are working with mechanical designers to help them achieve new product performance standards. Pre-engineered in combinations of tension, compression and shear for exact deflection requirements, these quality Dayton molded products replace metal-to-metal parts . . . eliminating grease fittings, reducing metal wear and maintenance problems, simplifying assembly, and giving long service.



Rubber tire in this flexible coupling is held by flanges and clamp rings . . . cushions shock loads, reduces torsional vibration, and accommodates angular and parallel misalignment and end float. A transverse split is molded into the tire, permitting replacement without disturbing the shafts. No lubrication is required.



Rubber-to-metal bushing, bonded for life to its inner metal by the quality Dayton process, accommodates torsional and angular motion at the radius rod ends. It provides a flexible pivot joint, eliminating metal wear and lubrication, absorbing shock, noise and vibration. With extreme radial stiffness and maximum torsional flexibility, this bushing is easy to install and can be positioned exactly.

Engineered rubber is the answer to your needs in vibration, noise and shock control . . . inherent misalignment of mechanical elements . . . simplifying assembly problems . . . and reducing maintenance costs. Dayton has design and production facilities to give you complete service from blueprint to finished product. Consult our molded product specialists.

THE DAYTON RUBBER CO., Molded Products Sales Div.
Three Rivers, Michigan

I have a design requirement and would like to talk more about it with one of your sales engineers.

*Name*_____

*Company*_____

*Address*_____

*City & State*_____

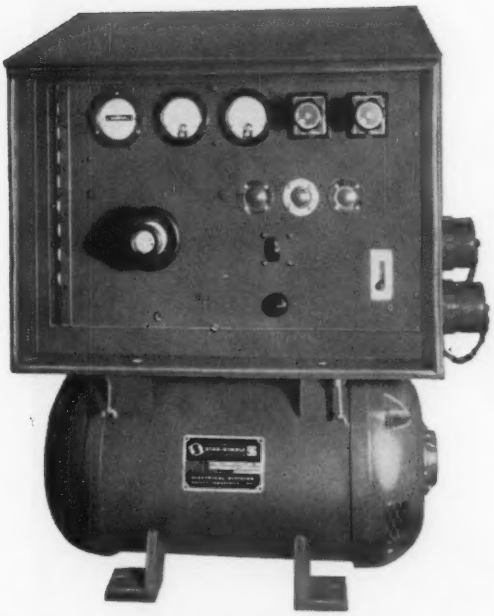
RUBBER RUBBER·TO·METAL RUBBER·TO·FABRIC

Dayton Rubber

MOLDED PRODUCTS SALES DIV., Three Rivers, Mich.

BRANCH SALES OFFICES IN: Dayton, Ohio • Detroit, Michigan Hillside, New Jersey • Atlanta, Georgia • Chicago, Illinois Dallas, Texas • Los Angeles, California

Circle 461 on Page 19



New "400"-Cycle POWER PACKAGE!

UNIT-MOUNTED

- **Motor**
- **Inductor-Alternator**
- **Regulation**

Motor-Generator Sets by

STAR-KIMBLE

Circle 462 on Page 19

THE PACKAGE:

- *A single compact unit.* Motor, alternator and controls built in one easily installed, space-saving construction.

THE MOTOR:

- 220/440 volts, 60 cps, 3 phase.

THE INDUCTOR-ALTERNATOR:

- *Wide choice of outputs.* Power range: Made in 1.5, 3, 5, 7.5 and 10 kw ratings at .8 power factor and with voltages of 120/208, 3 phase; 220/440 volt, 3 phase; 115/230 volt, single phase. Standard frequency 400 cps; other frequencies can be supplied.
- *Close voltage regulation.* Plus or minus 2%. (Plus or minus ½% can be furnished with special magnetic amplifier control).
- *Low maintenance.* No commutators, slip rings or rotor windings.
- *Low radio noise and harmonic content.*

THE CONTROLS:

- *Voltage regulator*—fast-acting automatic. Provision is made for adjusting voltage above and below normal values.

TYPICAL APPLICATIONS:

- Flight Simulators.
- Computers
- Aircraft Ground Support Equipment
- High-Frequency Machine Tools

The machine illustrated above is a 3 kw unit with many special design features not normally needed but indicative of variations available in this series of machines.

Write for complete information on standard designs—or outline your specific requirements for prompt attention by our Engineering Department.

ELECTRICAL DIVISION

including the STAR-KIMBLE product line

SAFETY INDUSTRIES, INC.

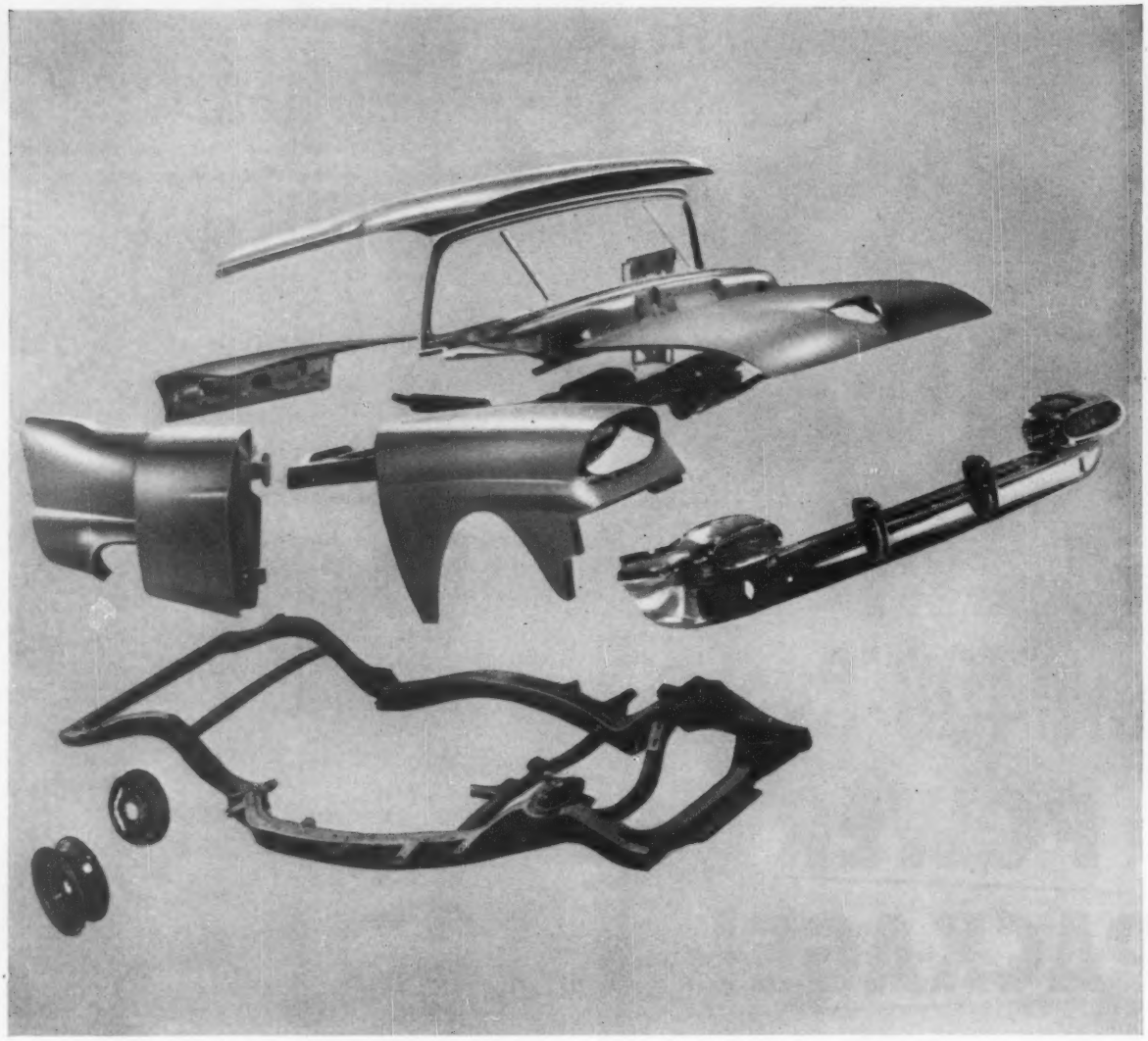
P. O. BOX 904 • TEL. UNiversity 5-3171 • NEW HAVEN 4, CONN.

ENTOLETER DIVISION
ELECTRICAL DIVISION

AUTOMATIC TIMING & CONTROLS, INC.
SAFETY RAILWAY SERVICE CORPORATION
INTERPROVINCIAL SAFETY INDUSTRIES LTD.

LIGHTING DIVISION
THE HOWE SCALE COMPANY

Motors • Generators • Disk Brakes • Special Motor-Generator Sets and Control Packages



Your car is about 70 pct sheet steel

The biggest safety feature of today's automobile is the rugged strength of the sheet steel in its frame and body. Yet rigid and tough as sheet steel is, it is also amazingly plastic. Between the dies of a press it literally flows. Fenders, bumpers, decks conform precisely to the designer's dream. One giant punch, and a rugged, one-piece roof panel emerges, ready for the assembly line.

Thousands of tons of Bethlehem hot-rolled and cold-rolled steel sheets go into parts, components and sub-assemblies of American automobiles. Bethlehem sheets are as uniform and as finely made as any on the market.

If you work with sheets, perhaps we can help you turn a problem into a profit. For prices and deliveries, just get in touch with the nearest Bethlehem office.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation.

BETHLEHEM STEEL

BETHLEHEM STEEL

BRUSHES

help give BLACK & DECKER INDUSTRIAL TOOLS power, long life, maintenance-free service

For more than forty years Black & Decker electric tools have been recognized by users as the most dependable and adequate tools of their kind. This reputation has been earned through rigid quality control, intensive research, testing and design engineering. To help make these tools first in performance and quality the world over, Black & Decker specify USG motor brushes. (Some of the industrial electric tool applications are pictured here.)

United States Graphite Company (USG) brushes are giving excellent service not only in Black & Decker products, but also in hundreds of installations, large and small, throughout industry. Because the brushes in any electric powered unit are so vital to the long life, power and maintenance-free service of that unit, it pays to specify USG brushes of carbon, carbon-graphite, electro-graphite, graphite, metal graphite or silver graphite.

Write for catalog B-56 and the USG grade list. Most of the information necessary to design engineers is contained in these two books.

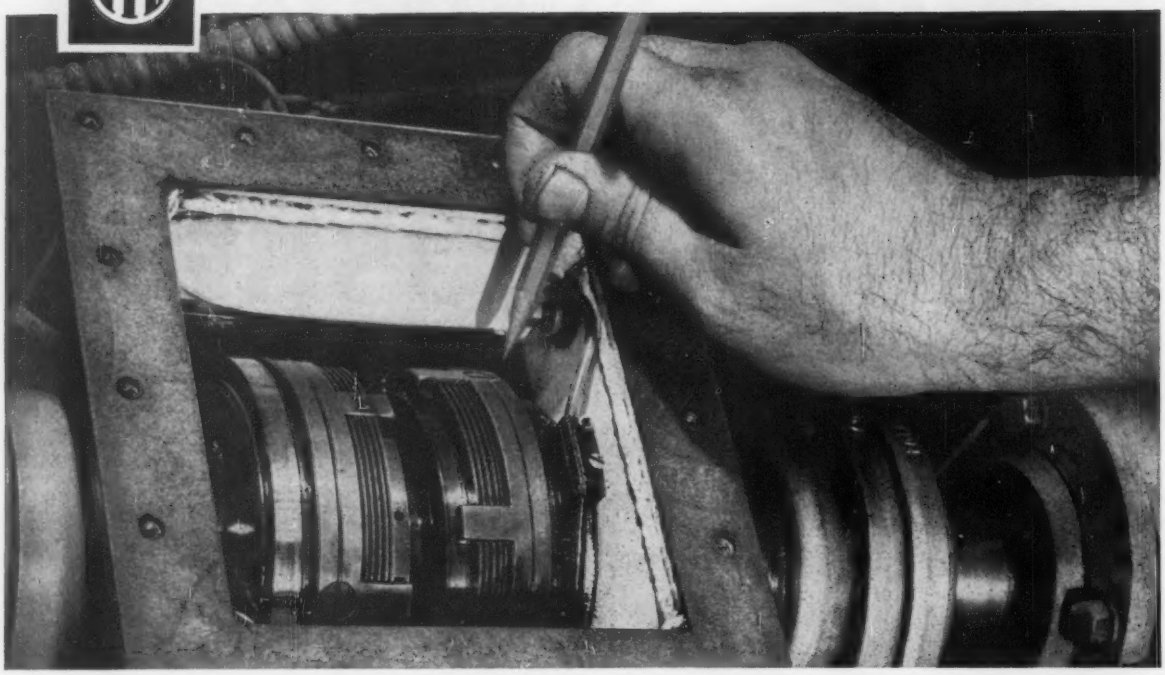
B-246-1

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 7, MICHIGAN

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDERED METAL PARTS • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

ELECTRO-CLUTCHES



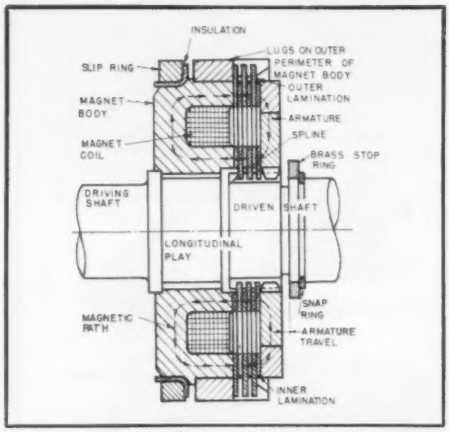
NO ADJUSTING

Get instant speed and feed changes for your machines without need for periodic checking and adjusting of clutches or gradual loss of torque. This is how: insist on genuine I-T-E Electro-Clutches.

No air gap. The patented closed magnetic circuit passing directly through the laminations provides tremendous torque in small space without need for maintaining precision air gaps. So the I-T-E Electro-Clutch goes right on giving uniform, troublefree clutching year in and year out.

More for your money. I-T-E Electro-Clutches are designed to operate in an oil bath. They can go right into your transmission box—often without altering dimensions. All-steel laminations outlast other clutch metals, plastics and friction discs—thus insuring longer clutch life. Safe 24 v operation permits use of telephone type relays, proved for dependability.

Select the exact clutch type you need from a wide range of stock models. For complete information, write I-T-E Circuit Breaker Company, Transformer & Rectifier Division, 19th & Hamilton Sts., Philadelphia 30, Pa.



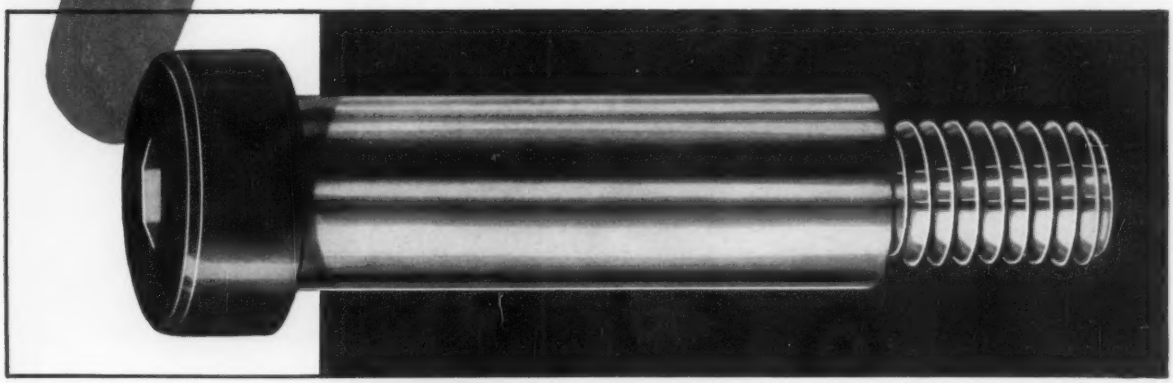
Principle of operation. Alternate laminations key with perimeter lugs and splined shaft respectively. Rotate freely until magnet coil is energized. Magnetic flux attracts the armature, compressing the laminations with great force, engaging clutch.

I-T-E Electro-Clutches are already in use by these leading companies:

Bullard Fosdick Sundstrand
Giddings & Lewis

I-T-E CIRCUIT BREAKER COMPANY
PHILADELPHIA, PENNSYLVANIA

Problem: *"Fasteners used to secure the stripper plate in this combination punch and die assembly must have close tolerances. Concentricity between head, shoulder and thread is an absolute must. High tensile strength is important. Head of fastener should be thin as possible to save space . . ."*

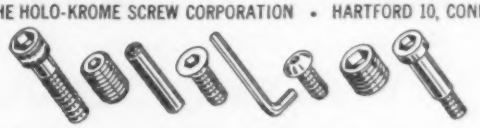


Solution: *HOLO-KROME SHOULDER SCREWS. Made of special analysis alloy steel. Hex sockets formed by the new H-K methods permit a thin head, still maintain high strength. Heat-treat warpage can now be completely removed. Both the screw shoulder and body are precision ground for exact concentricity before the body is threaded. Threads are Unified Class 3A Fit.*

For the finest in Hex Socket Screws . . . for unmatched Same-Day Service, the name to remember is Holo-Krome.

HOLO-KROME
SOCKET SCREWS

THE HOLO-KROME SCREW CORPORATION • HARTFORD 10, CONN.



SOLD ONLY THROUGH AUTHORIZED HOLO-KROME DISTRIBUTORS

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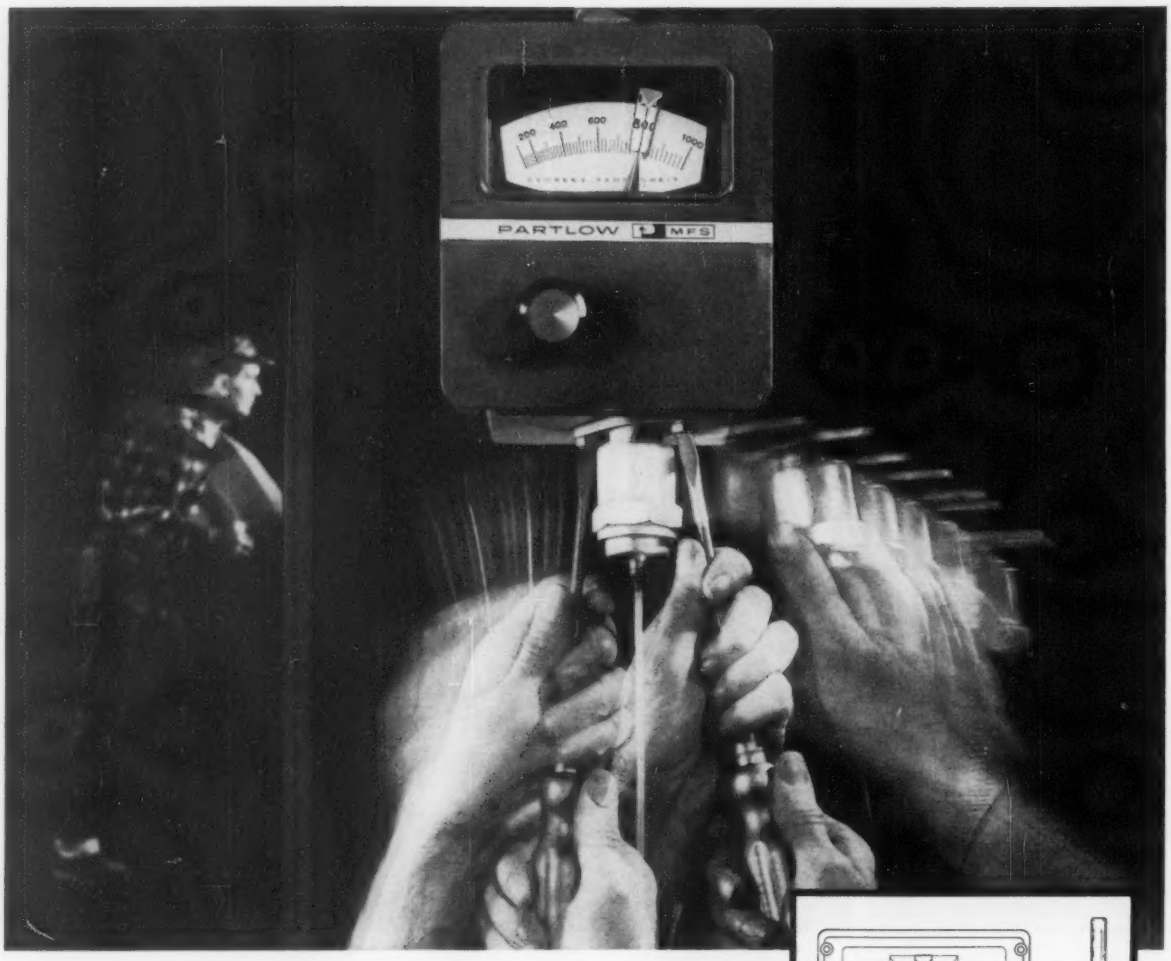


The Temperature Control Designed for Fast

"DO IT YOURSELF" MAINTENANCE

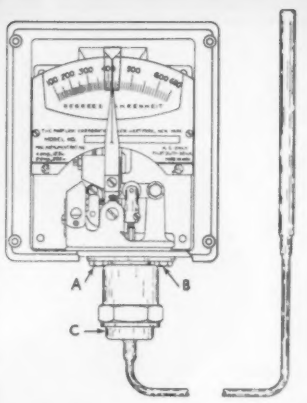
Right on the Job!

Rugged simplicity of design—along with the direct, positive power of mercury-actuation — combine to give Partlow maintenance and performance advantages no other type of temperature control can hope to equal.

Simplicity in the Partlow, for one thing, means that the control element can be changed *at the job site* in a matter of minutes with no other tool than a screwdriver . . . "Down time" is cut to an absolute minimum!

And simplicity in the Partlow also means the complete elimination of fussy electronic gadgets, delicate levers, hairsprings and other accessories that have a tendency to break down at the first trace of jar or jostle. Partlow controls are famous for their unfailingly accurate performance even under the most adverse operating conditions.

If you use or manufacture process equipment within the -30° to 1100° F. range, there's a Partlow pneumatic, electric or self-contained gas control (recording, indicating or non-indicating), to fit your application *precisely*. For details, write The Partlow Corp., New Hartford, New York. Dept. D-1258.



Diagrammatic view of the new MFS reveals "quick-change" feature common to all Partlow controls. In case of damage, merely unscrew at points (A) and (B), and remove element (C) from case. Reverse this process, and your Partlow is ready to resume operation.

You can pay more but you can't buy better than

PARTLOW

TEMPERATURE CONTROLS

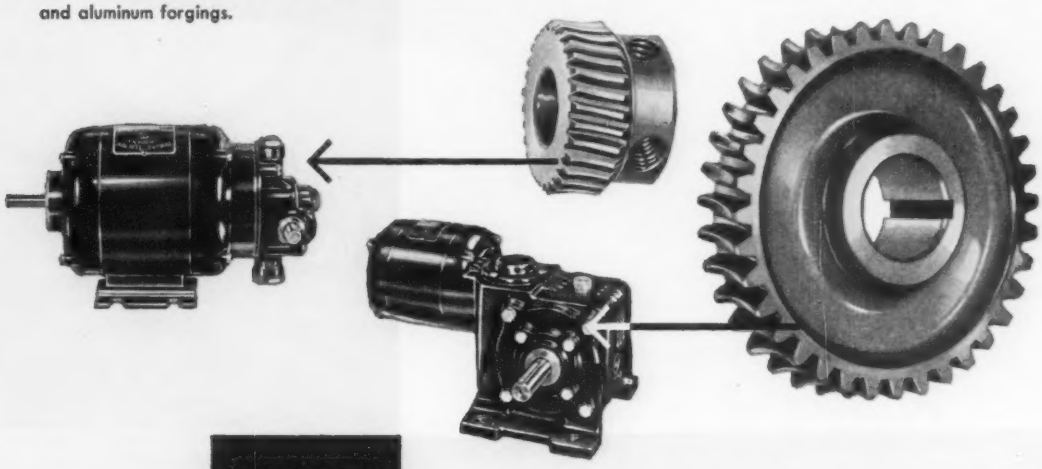
Circle 466 on Page 19

MUELLER BRASS CO. forged gears improve dependability and performance of BODINE electric motors

For combined high shear strength and maximum wear life in their single and double reduction speed reducer motors, Bodine Electric Company of Chicago uses gears forged from Mueller Brass Co. 603 Alloy.

Bodine has specified Mueller Brass Co. forged gear blanks because of their consistently high quality . . . there is no porosity, foreign inclusions or defects typical of cast blanks. The hot working of the metal followed by heat treatment to the desired physical properties produces a refined grain structure to give uniform machining and wear in service. The forged blanks are consistent in size and held to close tolerances. Bodine has also found that the excellent machinability of the blanks in the hobbing operation increases overall hob life.

For forgings of high tensile strength, high density, minimum porosity, light weight, corrosion resistance, good machinability and low costs with little scrap loss, it pays to specify forgings from the Mueller Brass Co., the world's largest producer of brass, bronze and aluminum forgings.



only the man from Mueller Brass Co.

can offer unbiased advice on the "one best way" of producing your parts, because Mueller Brass Co. is the *only* fabricator in the country offering all these methods of production . . . assuring you the best product at the best price . . . made the one best way.

Write today for complete catalogs on any of these products.

FORMED COPPER TUBE

PLASTICS INJECTION MOLDING

COLD-PREST IMPACT EXTRUSIONS

SCREW MACHINE PRODUCTS

POWDER METAL PARTS

RED BRASS CASTINGS

Also producers of: Super Cutting Red Tip Brass Rod • Aluminum Extrusions Aluminum Sheet, Coil and Strip • Plastic Pipe and Fittings • Copper Tube and Solder Type Fittings •

MUELLER BRASS CO. PORT HURON 20, MICHIGAN

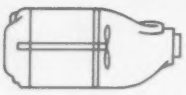
262

UNISEAL MOTOR *by* Franklin

...Franklineered

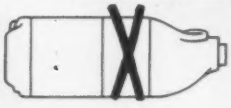
to improve pumps and other powered products

CUTS ASSEMBLY TIME



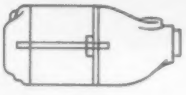
Pump impeller fastens to motor shaft, eliminating stub shaft, couplings and outboard bearings. Fewer parts, less assembly labor.

ELIMINATES ADAPTER CASTING



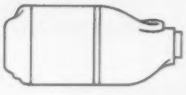
Seal cavity in end-casting enables mounting of pump without adapter casting. Reduces labor cost and parts inventory.

S/S MOTOR SHAFT IS RUSTPROOF



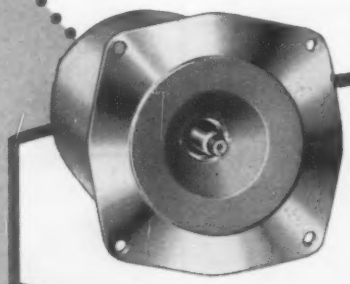
Corrosionproof stainless steel shaft guards against excess wear and seal leakage. Improves performance and longevity.

TOTAL WEIGHT IS GREATLY REDUCED



Integrated pump and motor save space and weight. Franklineering improves product appearance and performance, and cuts costs.

Precision-machined surfaces of mounting end are concentric with shaft to assure proper alignment of motor with powered product. Application-engineered to fit your products, the Uniseal Motor is available with or less base. Operates in horizontal or vertical position.



Franklineering...

describes Franklin Electric Company's advanced methods employed in design and production of application-engineered motors. Manufacturers who incorporate these motors with their products enjoy cost advantages in addition to superior performance. In the competitive water system market, leading manufacturers prefer dependable Franklineered Motors to provide product reliability.

Get the facts . . . write for Data Folder P86013

Franklin Electric Co., Inc.

345 EAST SPRING ST. • BLUFFTON, INDIANA

HOME OF DEPENDABLE ELECTRIC MOTORS

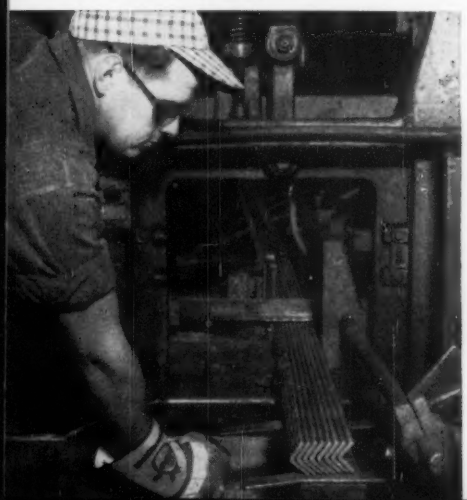
Circle 468 on Page 19

STEEL SHAPED TO CUT COSTS AND IMPROVE PRODUCTS

This is a picture of teamwork. C. G. Merker, U. S. Steel Metallurgist, discusses this cost-saving production change with Dick Sprucebank, Grating Shop Foreman, and Mr. P. H. Rollings, Division Purchasing Agent.

Stair tread nose plate made in one operation from steel already rolled to shape

One operation — sawing — completed this nose plate made from a special angle section rolled with a raised tread on the top side. Sawing 8 to 10 bars at a time speeds up operations, saves time and money.



Blaw Knox Company, Pittsburgh, makes thousands of open grate stair treads yearly. The nose plate was previously fabricated in such a way that excessive scrap losses and high costs were often incurred.

To solve this problem, U. S. Steel suggested a special angle section with a raised tread rolled on the top side. This eliminated shearing and forming operations, and the resulting scrap loss. The nose pieces could be sawed 8 or 10 bars at a time from 20-foot lengths of steel. The result was substantial savings in cost.

USS Special Sections can be made in many forms so that mass-produced parts can be cut to length as required and processed to finished parts by simplified fabrication. Frequently, this method will substantially reduce costs and result in improved parts. Why not write for complete information? United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

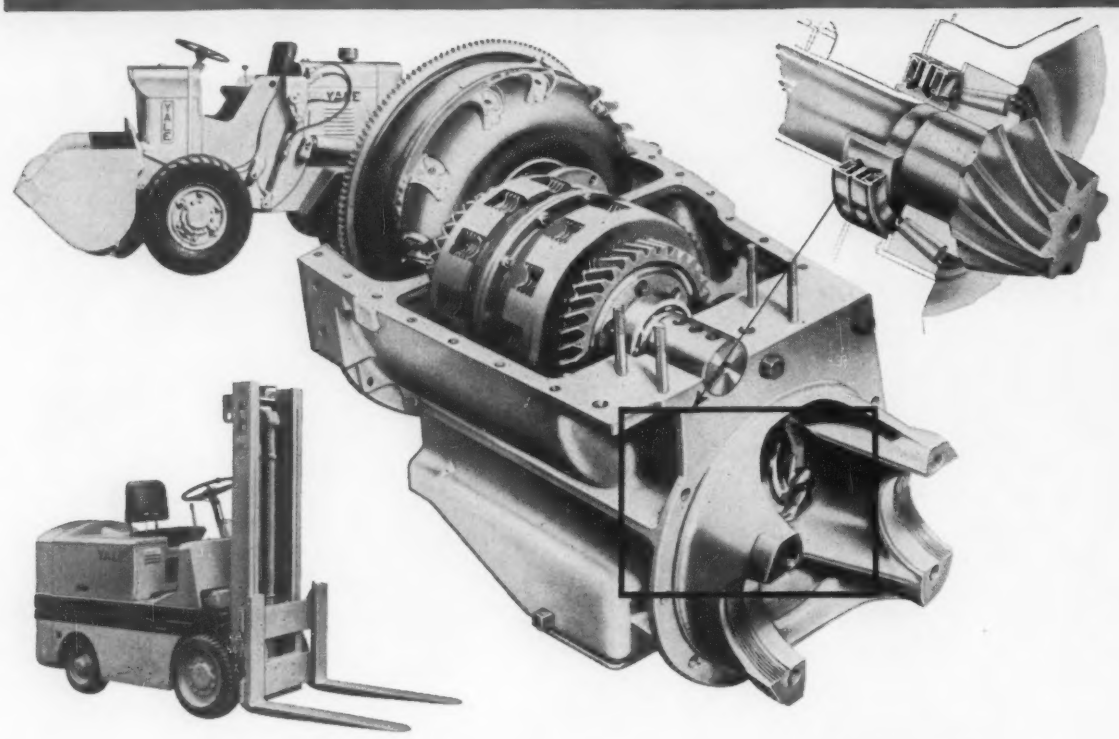
USS is a registered trademark

United States Steel Corporation—Pittsburgh
Columbia-Geneva Steel—San Francisco
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Export Company

USS **United States Steel**

Please direct inquiries to advertiser, mentioning MACHINE DESIGN

NATIONAL OIL SEAL LOGBOOK



Oil seals "back-to-back" in torque transmission of Yale industrial tractor shovels

In both their new industrial tractor shovels and the famous KGA51 series lift trucks, Yale and Towne employ National Seals to separate transmission oil from differential lubricant. The seals are used at the pinion position of the unique, fully automatic Yale Torque Transmission. This assembly is basically a combination of a torque converter and a constant mesh transmission eliminating gear shifting.

Pinion sealing almost always presents unique demands on oil seals; performance must be of the highest order since most pinion seals are difficult to reach for replacement after assembly, and repairs to adjoining assemblies are costly.

To assure long-term, trouble-free performance for their customers, Yale and Towne install two 50,000 series National Seals at the pinion position. The seals are mounted back to back, one with its lip facing and retaining transmission oil; the other with its lip facing and retaining differential lubricant. Both seals used are standard-design National Micro-Torc leather seals with precision-made tension springs insuring optimum seating of lip on shaft.

National offers over 2,500 different standard-design oil seals — leather, synthetic rubber or felt. National Seal engineers are at your service—they're listed under Oil Seals in the Yellow Pages.

NATIONAL SEAL

Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California
Plants: Van Wert, Ohio, Redwood City and Downey, California

Micro-Torc*— National's "break-through" in leather seals

Micro-Torc Oil Seals, developed by and made only by National, have established new performance standards for leather seals. They absorb less power, run cooler and last longer than any leather seal made. Properly employed, they have *no measurable leakage* throughout service life.

Micro-Torc Oil Seals are produced by *coating*—not impregnating—chrome retanned leather with a dry lubricant in an elastomer binder. The result is a mechanically stable sealing member which does not leak oil *through* the leather, but does permit the unimpregnated central part of the leather to absorb oil for periods of momentary lubricant starvation.

See, feel the difference!

Micro-Torc sealing lips actually *look* and *feel* slicker, smoother — their cool-running, high-lubricity coating is plainly apparent to the touch. Ask your National Seal engineer to let you *feel the difference!*

Circle 470 on Page 19

When you buy Motor Starters--

YOU PAY FOR OVERLOAD PROTECTION

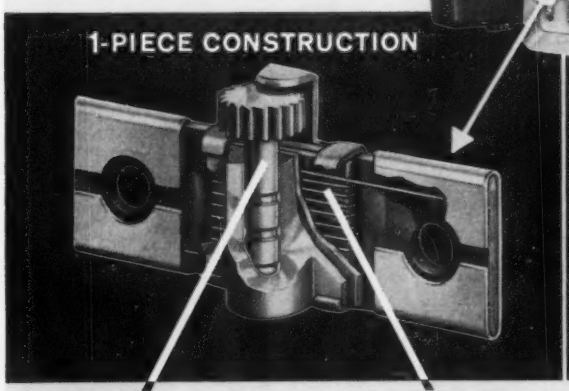
Only ONE-PIECE Overload Relays give 100% Protection • Only with ONE-PIECE construction can you *know* you've installed the heater correctly. Only with ONE-PIECE construction can you *know* the heater is exactly centered, or properly positioned, so that it performs according to its rating. Only with ONE-PIECE construction can you *know* your motors have full protection.

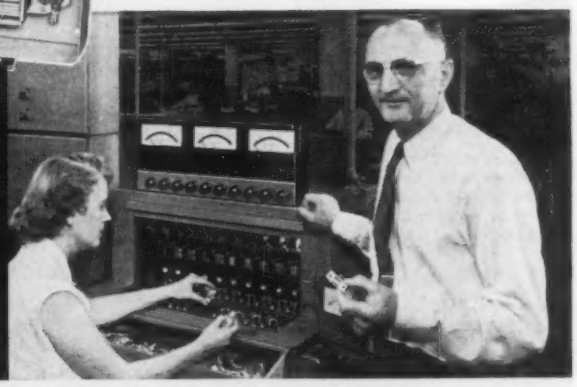
Only Square D has ONE-PIECE Construction • ONE-PIECE construction *eliminates* any possibility of heater misalignment. Square D melting alloy thermal overload relays can be installed only one way. They are tamper-proof. They are factory-assembled, are *individually* calibrated and tested. Repeated tripping will not affect accuracy.

Insist on Square D melting alloy thermal overload relays

***Write** for Bulletin SM-275 for the complete story on Square D starters with ONE-PIECE thermal overload relays. Address Square D Company, 4041 N. Richards St., Milwaukee 12, Wisconsin.*

...BE SURE YOU GET IT!





Heat-responsive element (solder pot) provides accurate response to overload, yet prevents nuisance tripping.

Heat-producing element is an integral part of overload unit. It's permanently joined to solder pot, can't become misaligned.

Individual factory inspection of every Square D melting alloy thermal overload relay means performance you can trust. Each unit is calibrated and thoroughly tested to make sure it will perform according to its rating.

EC&M HEAVY INDUSTRY ELECTRICAL EQUIPMENT...NOW A PART OF THE SQUARE D LINE

SQUARE D COMPANY

Circle 471 on Page 19

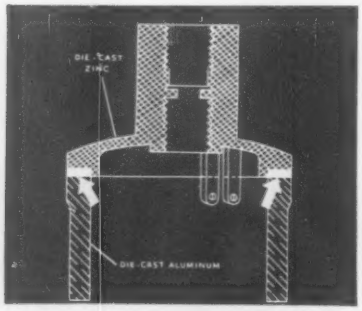
Technical data for gasket design and selection

NUMBER EIGHT

Avoiding electrolytic corrosion between flanges of dissimilar metals

When a joint is composed of dissimilar metals, the likelihood of electrolytic corrosion between flanges is greatly increased. In such cases, corrosion has been traced to plant fiber gaskets with glue-glycerine binders. Glue-glycerine binders are hygroscopic. The moisture accumulated in the gasket permits electrolytic action between dissimilar metals and results in corrosion.

A manufacturer of small gasoline engines was recently faced with this exact problem. Corrosion was attacking the aluminum float bowl and zinc float bowl cover, even on brand-new carburetors. Corrosion stopped when the gasket specification was changed to Armstrong CN-705 Accopac.



In this assembly, conventional plant fiber gasket permitted electrolytic corrosion between die-cast zinc and aluminum flanges. Switch to Accopac CN-705 eliminated this problem.

The non-hygroscopic binder in Accopac is synthetic latex. Since it does not attract moisture, corrosion cannot take place.

Accopac gasket materials are compressible, crush resistant, and will not shrink or dry out, even in alternately wet and dry applications. And because of their homogeneous nature, Accopac materials die-cut with sharp, clean edges.

Yet with all these advantages, Accopac costs less than materials of comparable quality. For more information about the advantages of Armstrong Accopac gasket materials, send for a copy of our bulletin IND-915.

Environmental factors in the selection of resilient gasket materials

In selecting a resilient gasket material, consideration should be given to certain conditions related to the internal and external environment of the gasket. These include such things as corrosion of flanges, the possibility of attack by fungus or ozone, and sticking of the gasket.

Flange corrosion. This can be caused by certain ingredients in the gasket, and it can also be the result of electrolysis between flanges of dissimilar metals. Both types of corrosion are usually associated with plant fiber gaskets that use glue-glycerine binders.

These corrosion problems can be avoided with Armstrong Accopac gaskets. Accopac materials have non-extractable synthetic latex binders which will not react corrosively with the contained fluid. These binders are also non-hygroscopic and will not encourage electrolytic action.

Gasket sticking. This is objectionable when a joint is subject to frequent opening and resealing and also where there is risk of damage to the flange when the gasket must be cut away.

Sticking is encountered most often where rubber-containing gaskets are used at ambient temperatures of 300° F. or above. It can be controlled or eliminated by coating the gasket with a release agent such as graphite.

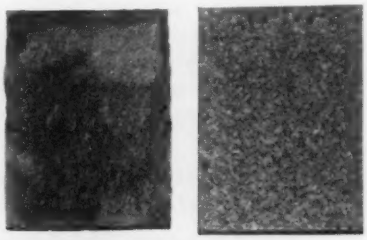
Sticking is not always an undesirable effect. In some cases, it acts to enhance the efficiency of the gasket.

Fungus attack. Certain atmospheric conditions favor the growth of mold and fungus, particularly on cork compositions and the more "corky" cork-and-rubber gaskets. This problem can usually be anticipated and can be prevented by the use of fungicides on the gasket.

A new Armstrong material—Uniphase Cork—is inherently fungus-resistant and can be used safely where fungus attack may occur.

Ozone attack. Ozone will attack and deteriorate some rubber and cork-and-rubber gasket materials. The extent of the damage is related to the concentration of the gas and the amount of stress on the gasket—with higher stress inducing more severe attack.

Among rubber and cork-and-rubber compositions, those using butyl as the base polymer offer the best resistance to ozone.



These samples of cork materials were inoculated with fungi in a standard test. Fungus attack on conventional cork composition is shown at left. Armstrong Uniphase Cork at right has special binder which makes Uniphase fungus resistant.

Where cork-and-rubber gaskets are attacked by ozone, it may be possible to substitute Armstrong Uniphase Cork. This material has many of the characteristics of cork-and-rubber, but it is completely resistant to ozone.

A more complete discussion of the environmental factors that affect gasket selection and performance is contained in the Armstrong Gasket Design Manual. Write for your copy to the address below.

For your copy of Gasket Materials catalog or new Gasket Design Manual, write to Armstrong Cork Company, Industrial Division, 7112 Dean St., Lancaster, Pa.

Armstrong GASKET MATERIALS

. . . used wherever performance counts

Circle 472 on Page 19

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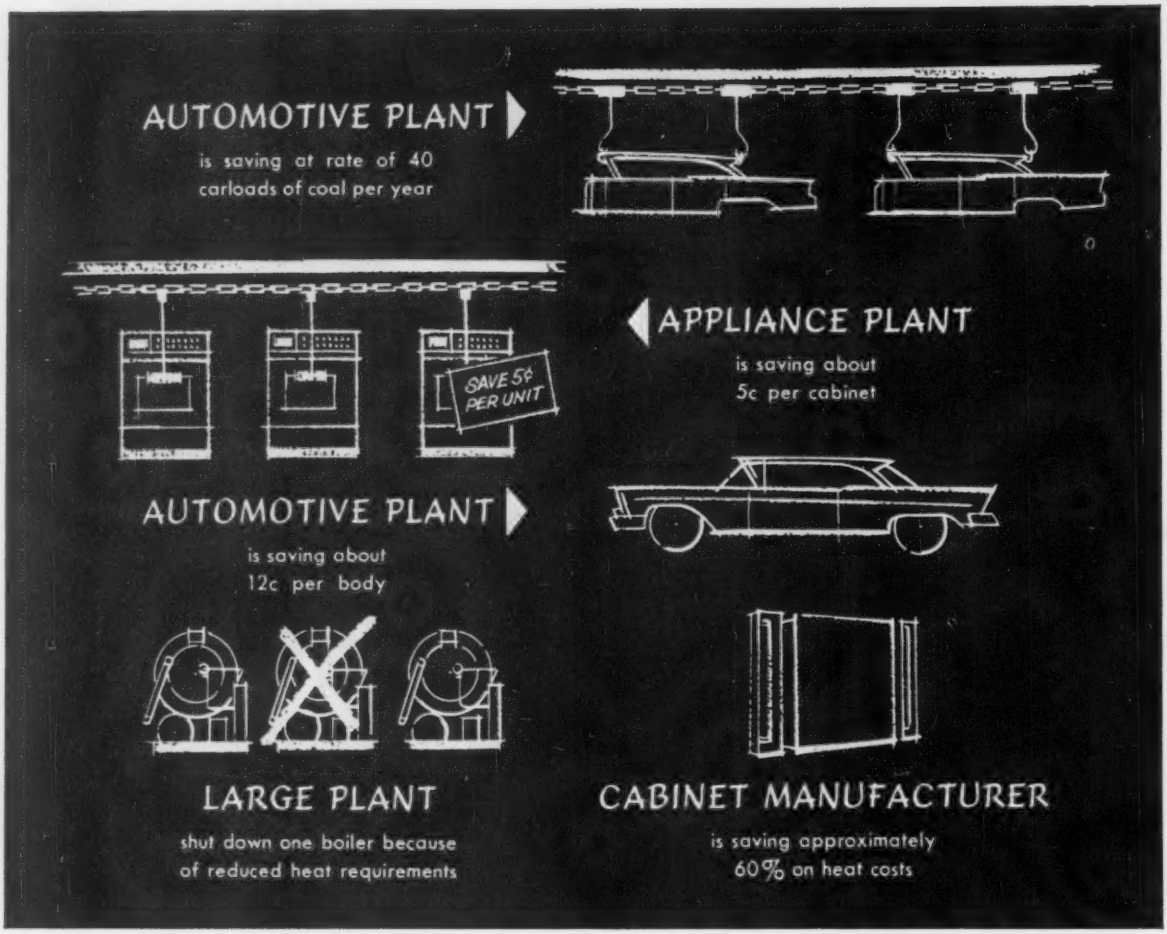
Circle 473 on Page 19



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Results produced by the Cold Bonderite System equal the highest Bonderite quality standards. Chemical costs are comparable to hot systems.

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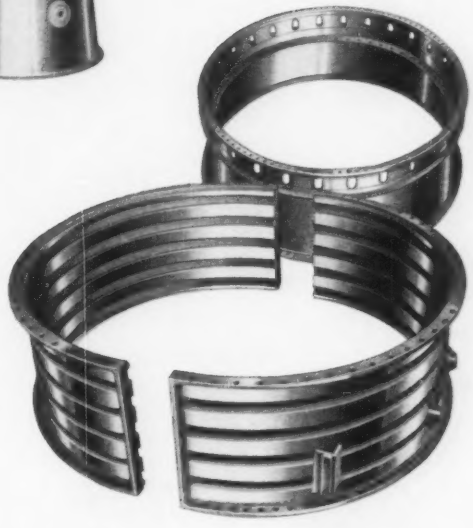
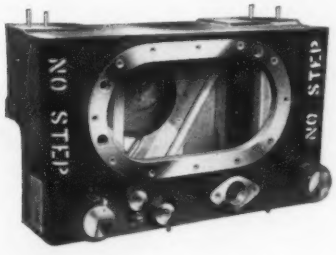
Circle 474 on Page 19

Looking for a Fabricating Source...



of welded precision assemblies?



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AMERICAN WELDING

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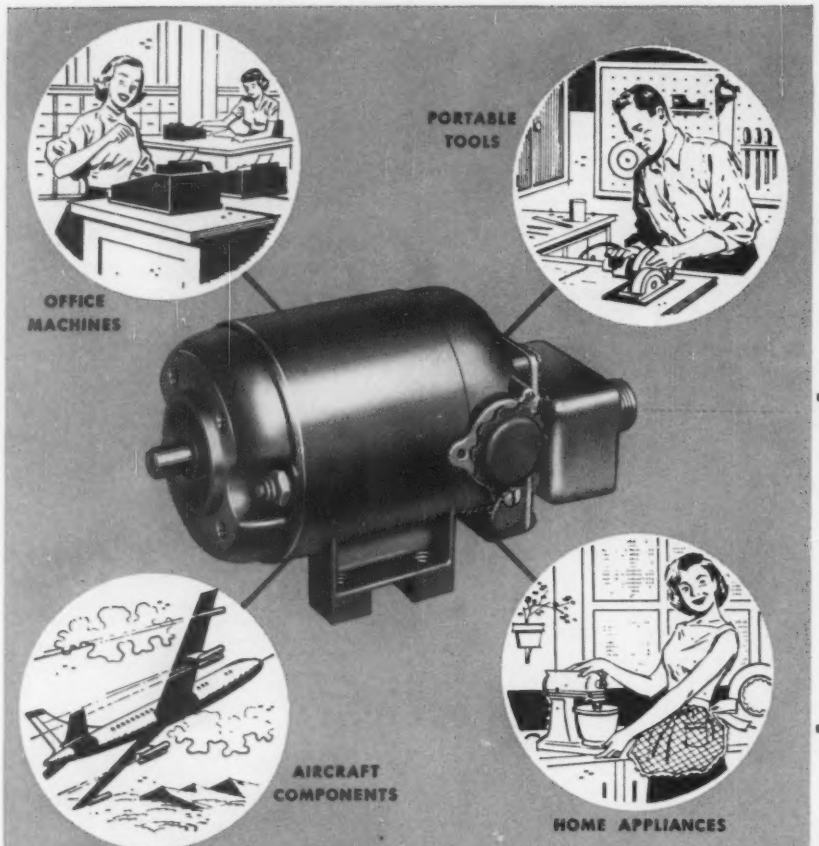
NEW 20-page catalog of Amweld Rings, Bands, and Welded Assemblies.
NEW booklet entitled, "HOW AMWELD FLASH BUTT-WELDED RINGS ARE PRODUCED."

Circle 475 on Page 19



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(2) the low weight and compactness required for easy portability and good product *appearance.*

These advantages are standard with Lamb Electric Motors, at no increase in cost, because our plant is equipped and organized to *custom manufacture on a volume basis.* May we demonstrate?

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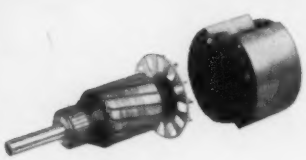
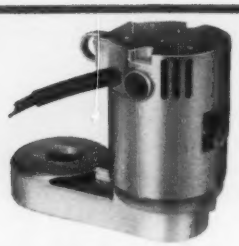
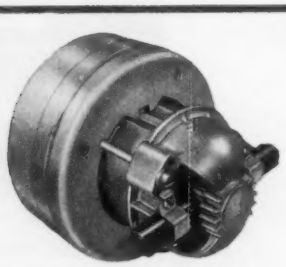
Circuit breaker actuator motor.



Motor parts for portable electric tools.



Impact concrete drill motor.



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Lamb Electric

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Circle 476 on Page 19

IT PAYS TO STANDARDIZE ON **STANSCREW**

Stanscrew service prevents problem for manufacturer of journal bearings

The wise manufacturer eliminates any possibility of fastener breakage *before* it can become a serious and expensive field problem.

As a prime example, a leading manufacturer of sealed cartridge journal bearings was concerned about the cap screws used to hold one essential part—the thrust cap—in place. They knew the lateral movements of a railroad car resulted in thrust on this cap, imposing extremely heavy loads on these fasteners.

A call to their industrial distributor soon had a Stanscrew fastener specialist on the job. He recommended continued use of a torque wrench and worked out the proper setting so that each fastener carried its rated load. Subsequent laboratory tests proved these recommended torque settings insured against fastener breakage.

The manufacturer accepted these recommendations . . . and thus eliminated a potentially serious problem before it could develop. The torque settings and technique developed by the Stanscrew representative have been incorporated in the company's instruction and maintenance manual to insure proper maintenance procedures.

Technical assistance like this is just one of the many reasons more and more manufacturers are standardizing on Stanscrew. Trained specialists, backed by an outstanding engineering staff, can solve your particular fastener problem. In addition to assuring the dependability of your product, often they can save you money . . . for example by substituting a standard fastener for a costly "special".

Call your Stanscrew distributor today for the answers to your fastener problems. He will see that the Stanscrew Fastener Specialist visits you without delay.

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Circle 477 on Page 19

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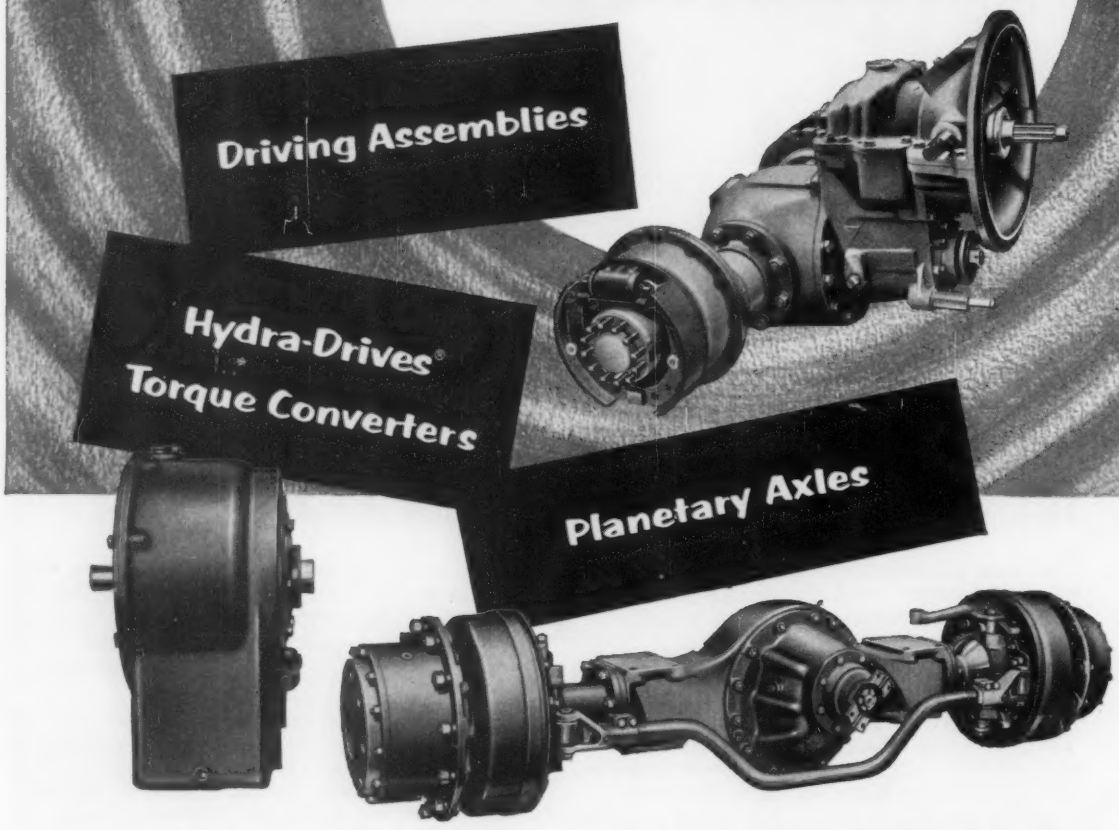

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ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

DESIGN
December 11, 1958

Worth More Than Money

FIRE had totally destroyed the artist's studio. The insurance adjuster, checking artists' supply catalogs, valued the lost canvases at an average of five dollars each.

"But," exploded the artist, "these canvases had been painted!"

"In that case," replied the adjuster, "let's say two-fifty apiece."

How about a finished engineering drawing? What is it worth? Figures cited by Jay Bergen suggest an average investment of $112 to $160 for one drawing. Assuming a typical 34-inch by 22-inch drawing, the cost works out at $22 to $30 per square foot.

Dollar bills are worth $9 per square foot.

You can pursue this line of thought for yourself. Try figuring the cost of a drawing per ounce. Just about worth its weight in gold, isn't it?

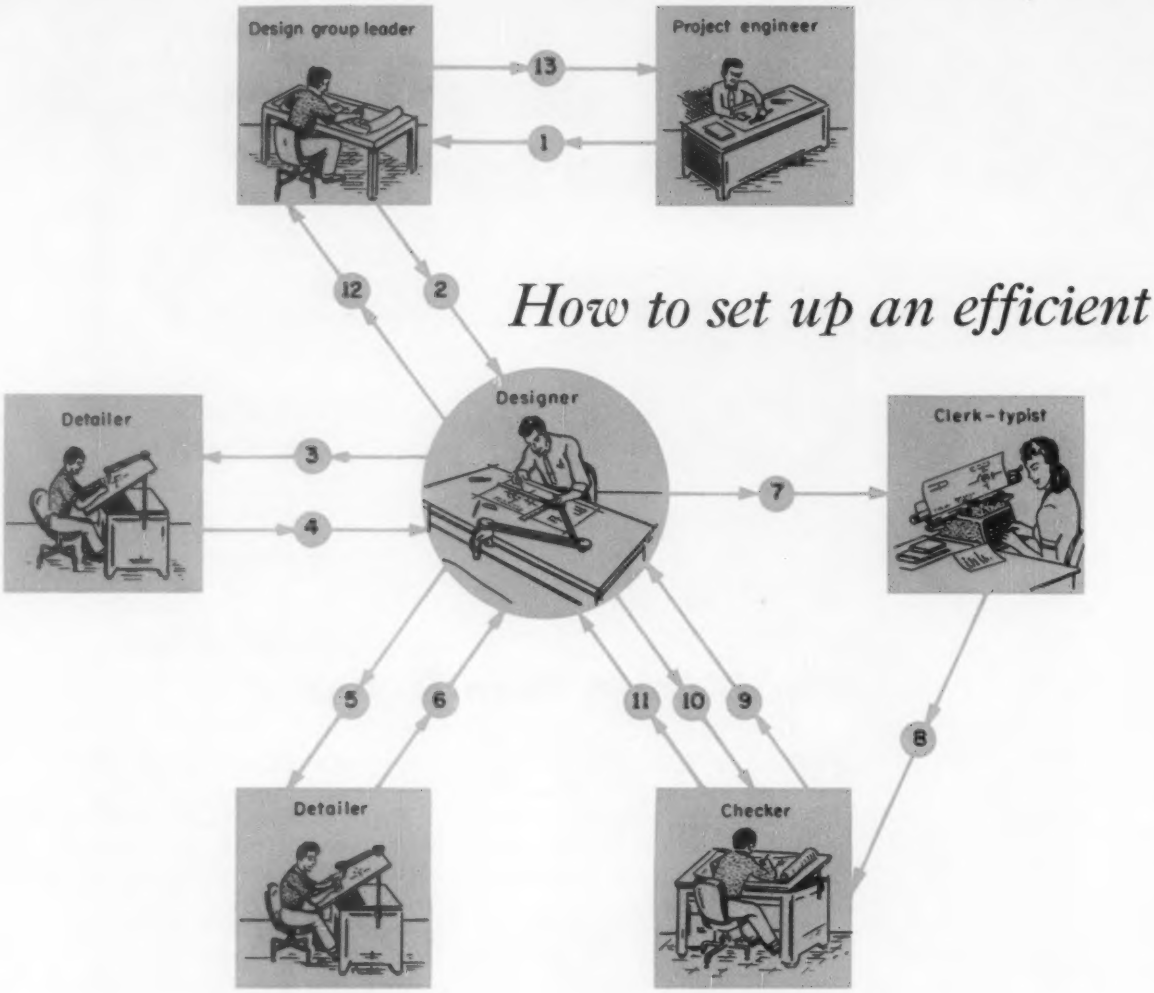
Viewed in this light, the problem of safeguarding engineering drawings is comparable to that of the banker. It demands no less stringent controls, short of hiring Brinks to protect them.

Jay Bergen is a longtime crusader for lower drafting costs. His timely article in this issue gives valuable pointers both on controlling costs and on safeguarding the high investment in engineering drawings.

Reminder: Drawings are worth more than money!

Colin Carmichael

EDITOR



How to set up an efficient

By JAY H. BERGEN
Director
Engineering Services Laboratory
American Machine & Foundry Co.
Stamford, Conn.

DRAWINGS ARE EXPENSIVE! The average drawing is made at a cost of about $8 an hour if the costs of supervision, checking, supplies, reproduction, etc., are included. On the average, a drawing takes 14 to 20 hours to produce. It is obvious that almost any drawing-control system which can reduce such high drafting costs can be worthwhile.

Why Drawing Control

There are many reasons other than direct costs for maintaining strict control over all drawings. High among these reasons is safety from loss or damage. Also, a drawing-control system makes it easy to locate an original drawing at any time for any authorized individual.

There is a story told about a designer who worked a few years ago in one of AMF's drafting rooms before a drawing-control system was instituted. Each morning this designer withdrew from an open file the tracings he would need for the day. Under his drafting board, he kept a clean wastebasket in which he stood these drawings tightly rolled for use as he needed them.

One night he forgot to return them to the open file. The inevitable happened. The maintenance man found the drawings in the wastebasket, assumed they were discarded drawings, and threw them in the incinerator. These drawings were replaced in time—partly from memory and partly from such

DRAWING CONTROL SYSTEM

details as had been completed. But considerable overtime and much tearing of hair accompanied their loss.

▶ Setting Up A System

Before a system of drawing control can be set up, all the normal steps through which a drawing progresses from an idea to a finished print must be analyzed.

First of all at AMF, a design group leader works with each designer in establishing what is to be shown on a given drawing. As the designer progresses in developing the idea, detailers are called in to work out specific details. When a drawing is completed the first time around, it is sent to a clerk-typist for adding notes and comments. Then the drawing is sent to a checker for careful review. Usually the drawing comes back to the designer and detailers for making any necessary corrections and is sent to the checker again. If no further inaccuracies are found, the drawing is passed on to the group leader and the project engineer for authorization to have reproductions made.

Usually this is the procedure for making a finished drawing. With all this handling, it is easy to see how a drawing could be defaced, mislaid, or lost.

An adequate drawing-control system should:

1. Keep accurate and up-to-date records of the location

Fig. 1—Drawing schedule card for planning and controlling starting and completion dates of drawings. It shows the status of all drawings related to a project, percentage completed, number obsoleted, number in process

DRAWING SCHEDULE
DESIGN SUMMARY
DATE-SELECT CONCEPT 1-15 1-17
DATE-LAYOUT APPROVAL 2-12 2-10
DATE-COMPLETION OF DETAIL LAYOUT 2-25 2-27
TOTAL NO. DESIGN HOURS 8 20
NO. OF HOURS TO DATE
DETAILING SUMMARY
NO. OF END PRODUCT DWGS. 6 6
DATE-COMPONENT RELEASE 9-1 9-2
TOTAL NO. HOURS DETAILING 180 230
TOTAL NO. HOURS CHECKING 50 46
NO. OF HOURS TO DATE
GROUP LEADER
DATE ISSUED
ITEM NO. DWG SIZE DWG CAT DRAWING NUMBER DRAWING TITLE DATE SCH'D STANDARD DATE DRAFT CHECK ESTIMATED DATE DRAFT CHECK ACTUAL DATE DRAFT CHECK ACT # HRS DRFT CHK DRAWN BY REMARKS NOTE POST
56 E 1300 CHASSIS ASSEM-STEPPING SWITCH 10/30 S 5/6 S 7-1 S S S 7-2 S 10-13 60 10 R.D.
F 7-1 F 7-31 F F 10-15 F 7-15 F 10-15
57 E 1301 CHASSES, STEPPING SWITCH 7/1 S 3-2 S 4-16 S 6-2 S S 2-26 S 6-5 80 20 W.E.
F 4-1 F 5-1 F 6-27 F 6-10 F 5-13 F 6-12
CLASS 590 DIV 206 PROJECT ANTENNA JOB ORDER 183-6-58
TASK NO. 11 TASK TITLE CHASSIS MECH DWGS COMPONENT SHT 3 OF 4
7½ in.

and current status of all drawings.
2. Minimize the handling of original tracings to reduce the possibilities of damage and deterioration.
3. Minimize the number of times the original-tracing must be reproduced, while making sure that all cognizant persons will have access to the latest information which appears on a given drawing.

Drawing Schedules

To achieve complete control over any drawing from start to finish, two "tools" are helpful—a drawing schedule and a drawing record card. A formal written procedure is also supplied for using each of these.

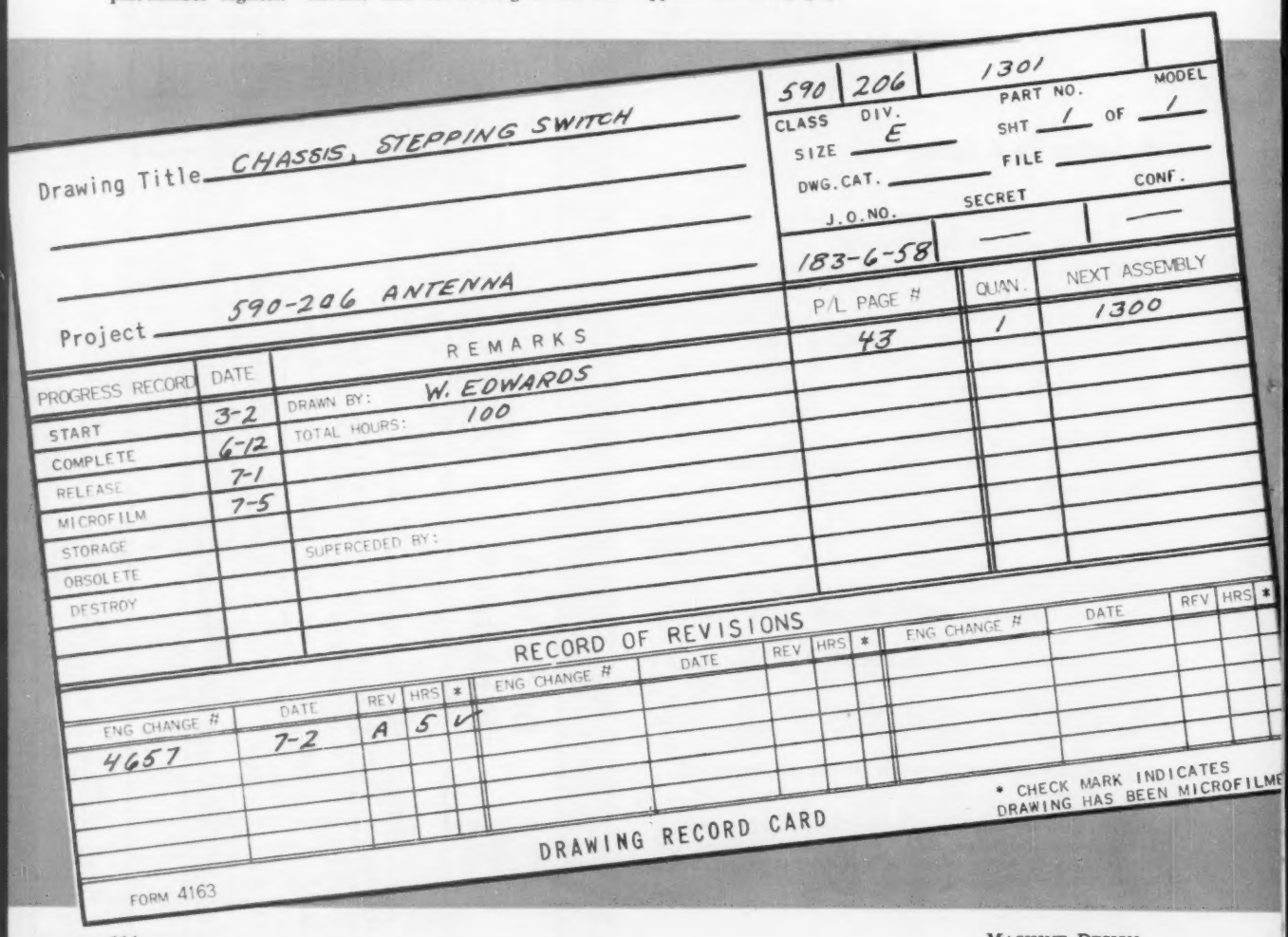
A drawing schedule, Fig. 1, serves the following functions:

1. Aids the group leader in estimating the time required to complete a design or drafting effort for a project.
2. Establishes target dates for designers and draftsmen and helps to alert shop facilities in scheduling work.
3. Serves to keep the project engineer and the design and project supervisors informed on the progress of a design.
4. Permits the drafting group leader to assess and evaluate efforts of personnel in his charge.
5. Provides ready reference to summaries of estimated hours to completion as well as actual time spent in the design and drafting phase of any project. This function is a big help in controlling costs.
6. Provides a running account of the status of all drawings on a project, the percentage completed at any time, the number marked obsolete, and the number still to be completed.

It is the responsibility of the design group leader to keep the drawing schedule up to date.

At the beginning of a project, the group leader allots time for establishing concepts for a given area. He prepares an initial drawing schedule during the planning period, working with the project engineer. At this stage, the estimated completion date can be the date established by engineering for selection of concepts. The group leader can list all concept layouts for a given task on the same

Fig. 2—Drawing record card for showing preparation time, changes made, drawing location, etc. Initial data for the card are obtained from the drawing schedule and the part-number register. Reverse side of drawing record card appears on facing page



schedule sheet. On the estimated date, all concepts are submitted to the engineering group regardless of the state of completion, with any recommendations the design section chooses to make.

From this stage, engineering selects one or more concepts to be developed for approval layouts. Any drawing which is not selected for further exploration is marked inactive and so listed in the remarks column of the drawing schedule.

Drawing Numbers

Accepted drawings are assigned numbers previously issued by a drawing-control group. The formal number will show:

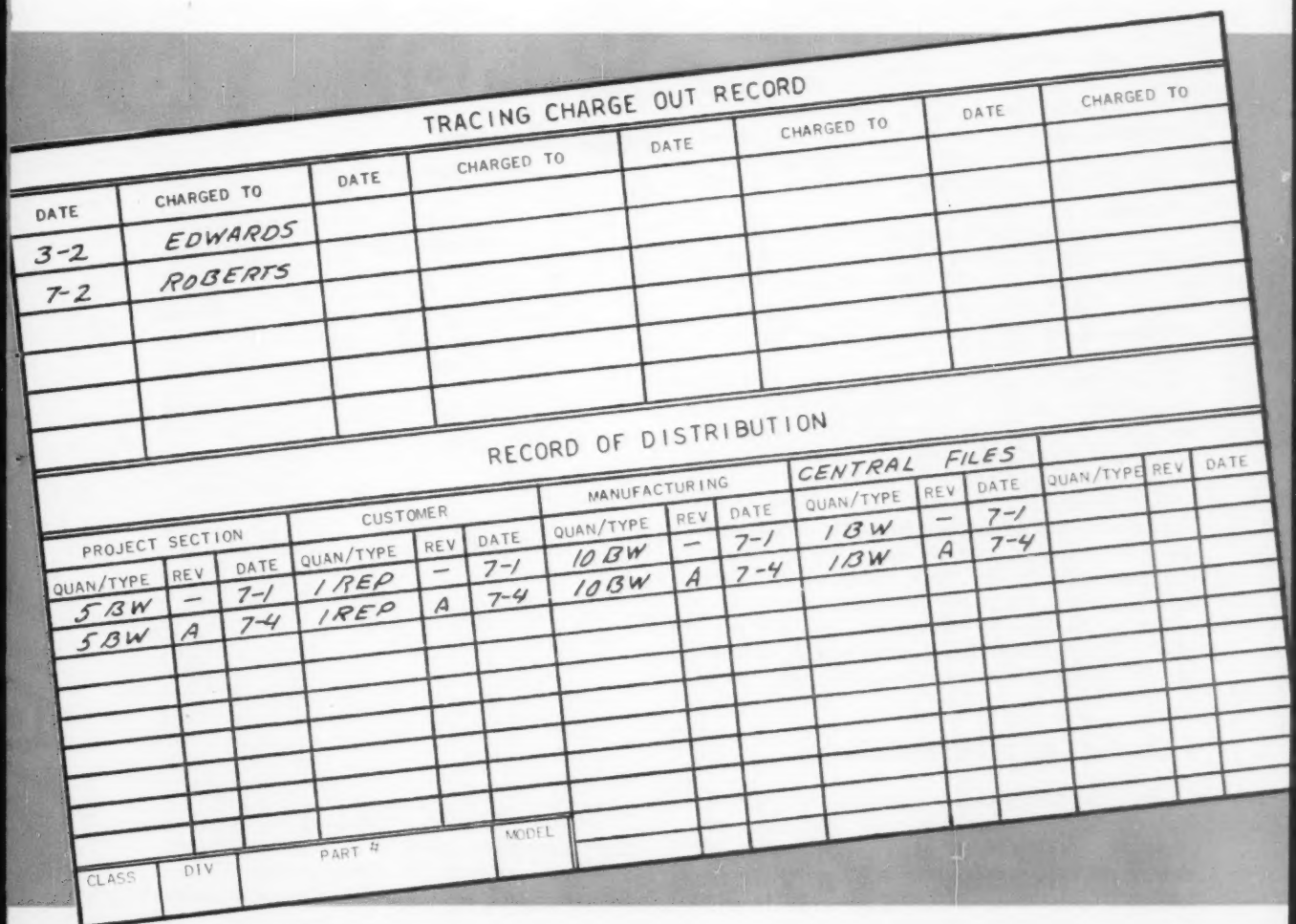
1. The class of the contract which applies to the drawing.
2. The division originating the drawing.
3. The actual number of the drawing in its own series for a particular project.

In addition to the drawing number, standard starting and completion dates are entered on the schedule for all time numbers assigned. All other known data which affect the drawing are entered on the schedule at the same time. As work progresses, revised starting and completion dates are entered in the estimated-date column.

When this drawing schedule is used, only items of value to the group leader, project engineer, and project control group need to be entered on the schedule. Information is *not* added merely to fill the blanks.

Each week, prints of the drawing schedule are distributed to cognizant personnel, according to local plant procedure. In our organization, these usually include the design manager, the drawing control group, the project engineer, and the project control group. The date of issue is the day ending the period for which the schedule is effective. Any new entries for that week are indicated by a check mark in the note-post column to show that new information has been added to that line.

The use of this type of drawing schedule, carefully administered, insures positive control and sched-



TRACING CHARGE OUT RECORD

DATE	CHARGED TO	DATE	CHARGED TO	DATE	CHARGED TO	DATE	CHARGED TO
3-2	EDWARDS						
7-2	ROBERTS						

RECORD OF DISTRIBUTION

PROJECT SECTION			CUSTOMER			MANUFACTURING			CENTRAL FILES					
QUAN/TYPE	REV	DATE	QUAN/TYPE	REV	DATE	QUAN/TYPE	REV	DATE	QUAN/TYPE	REV	DATE	QUAN/TYPE	REV	DATE
5 BW	—	7-1	1 REP	—	7-1	10 BW	—	7-1	1 BW	—	7-1			
5 BW	A	7-4	1 REP	A	7-4	10 BW	A	7-4	1 BW	A	7-4			

CLASS | DIV | PART # | MODEL

uling of drawings which are in process. Further, it shows from day to day the progress made on any particular drawing and on the total number of drawings for any project.

But how are individual drawings recorded, stored, and protected against damage and loss?

Drawing Record Card

AMF uses a drawing record card, Fig. 2, on which is entered a lifetime history of every drawing, as that drawing progresses through preparation. This card shows changes and revisions, and it indicates the location of the original drawing at any given time.

When any drawing is started, it is given a number, and its size is indicated by a standard procedure. From the drawing schedule, such data as the project name, phase of the project, contract number, etc., are transferred to the record card. At the discretion of the drawing control group, the type of drawing is indicated, i.e., whether the drawing is a layout, an assembly drawing, a detail, or whatever its classification. The active-job order number under which the drawing will be made is indicated. Of course, the classification must be entered if the drawing is to show classified information.

Down on the left-hand side of the card there is a complete life history of the drawing, including microfilming and other records which may be necessary. The card is also used to show when a drawing becomes obsolete and when it was destroyed, if such is the case.

In the center section is a space for the draftsman's name, the total hours spent on the drawing by various draftsmen, detailers, or any subsequent effort. There is also plenty of room to indicate whether any drawing supersedes the one for which the record is kept.

If there is a parts list for the particular drawing, the parts-list number is shown along with the number of the next assembly drawing. On the same side of the card, a complete record of all revisions and engineering changes is kept.

The reverse side of the card, Fig. 2, shows a complete tracing charge-out record. At the discretion of the drawing-control group, tracings can be removed from files only to make reproductions, or to perform some physical change to the drawings.

Also on the reverse side of the card is a complete record of distribution of prints of a given drawing and an indication of who received them.

Drawing-Control Responsibilities

Obviously, the engineering drawing-control group has the prime responsibility for recording and preserving all drawings. This group handles all change requests, maintains an engineering change-number register, keeps drawing cards up to date, and makes sure that a reproducible copy of each drawing is made as it exists before any change is made. This last step assures that even if a drawing is lost or defaced beyond recognition there will be in the file a means of reproducing it.

When a drawing change has been made, the drawing-control group distributes copies of the revised drawing to all those who are on the distribution list to receive the original drawing.

The drawing-control group has the responsibility for storing all drawings on a project until all activity on that project has been completed. Then and only then may they request that original drawings for the project be transferred to dead storage.

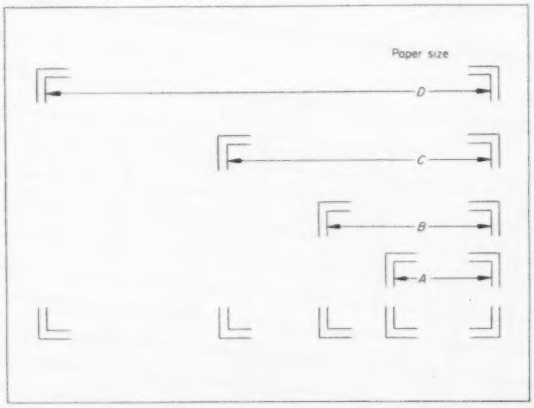
This system, of course, demands that there be a carefully trained drawing-control group at each location where design and development work is carried on. It demands further that this group must be always on guard to see that standard procedures are followed. They are responsible for maintaining drawing schedules and record cards for all tracings. It is up to them to do the policing necessary to insure that all principal elements of the standard procedure are carried out.

It is also necessary, of course, that local engineering management back up the drawing-control group in its day-to-day decisions to avoid favoritism and to avoid short cuts which may jeopardize the system.

Tips and Techniques

Format Layouts

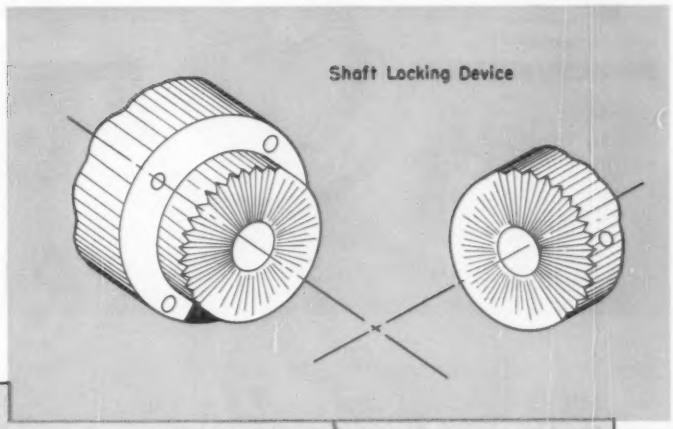
To eliminate dull, repetitious scaling of border lines, the border line intersections for the various sizes of drawing paper can be drawn on the board cover as shown. These markings for small sheets

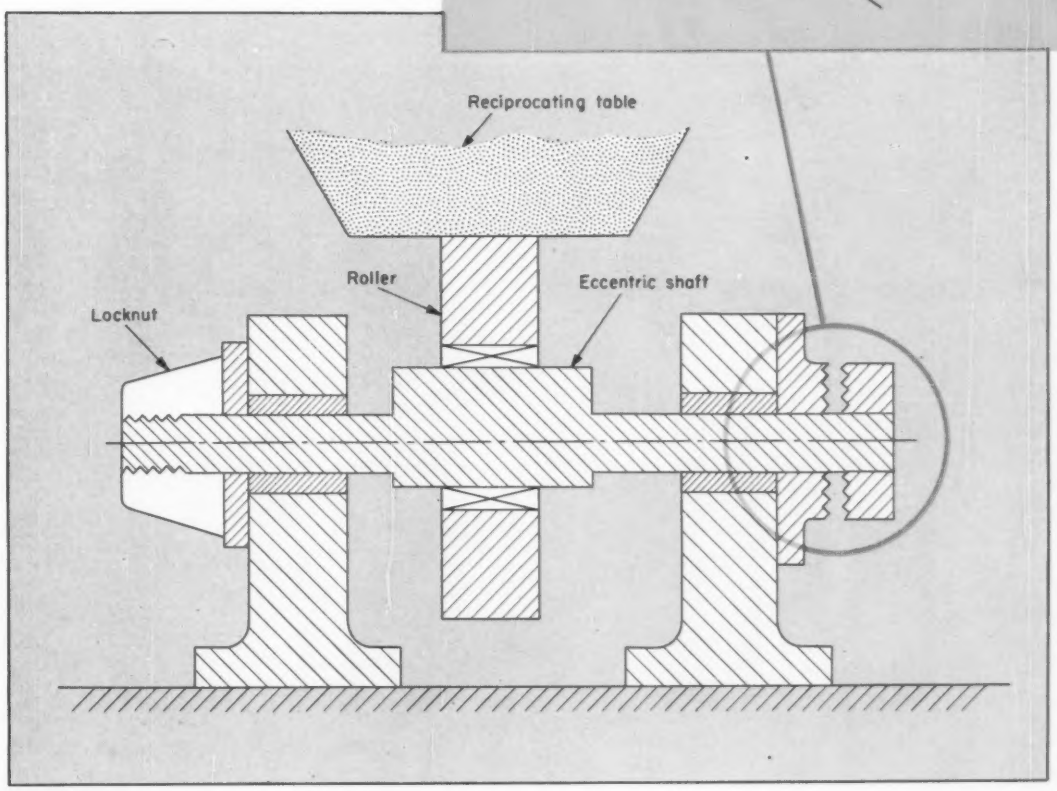


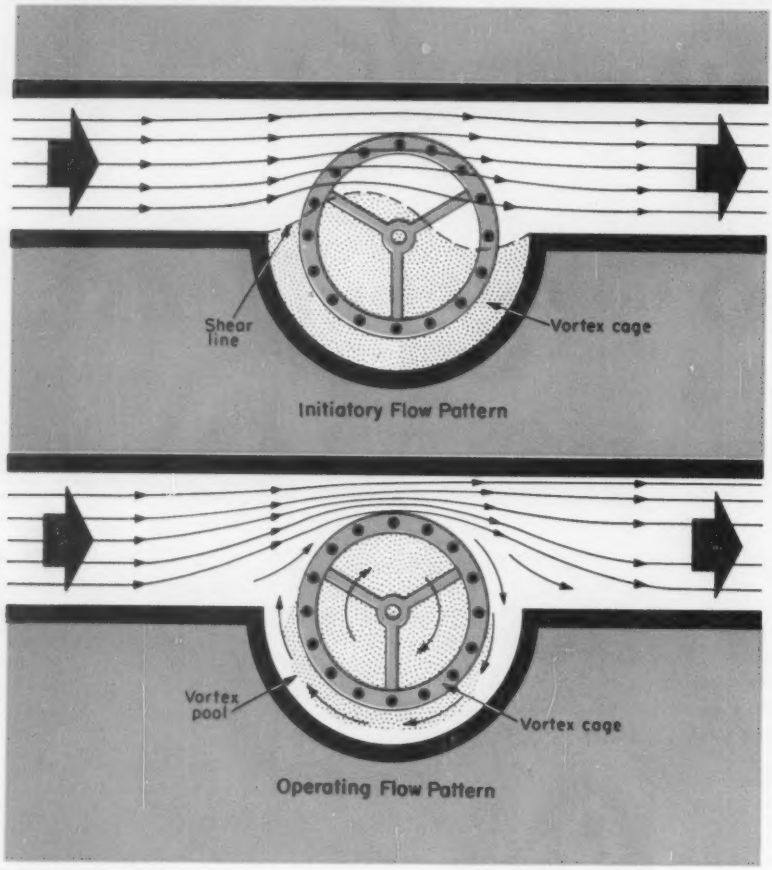
will not interfere when drawing on a large sheet, and the borders can be easily drawn along a straightedge aligned between two corner points.—Howard J. Meyers, *Danielson Mfg. Co., Danielson, Conn.*

scanning the field for *ideas*

Positioning and locking of an eccentric adjustment is provided by serrated hubs attached to shaft and shaft support. In a reciprocating table design reported by Herbert A. Krivka of Vitro Laboratories, the unit adjusts table height and provides takeup for wear.

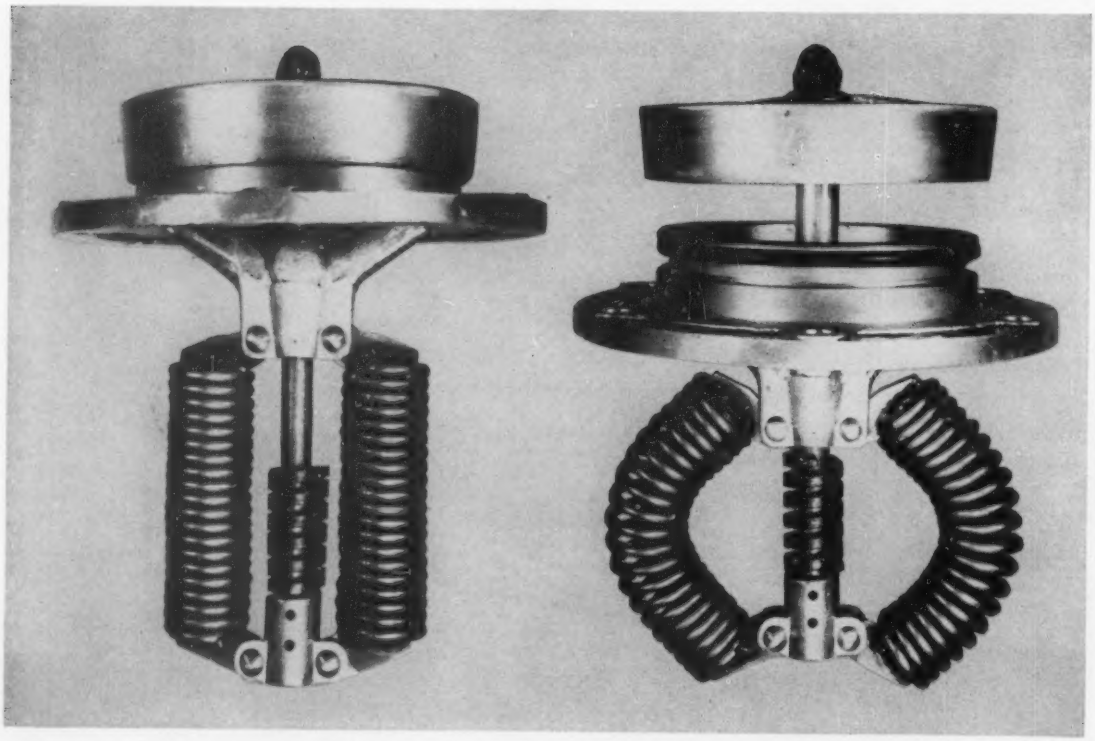






Volume-sensing vortex rotates at a velocity proportional to flow rate. In a gas flowmeter by Rotron, a paddle-wheel cage rotates at the same speed as the vortex. Direct volumetric readings are obtained by counting the cage revolutions.

Snap action is produced when springs buckle under an applied force. In their initial position, the springs resist a large force. Once buckling starts, less and less force is required to cause further deflection. This principle is employed by General Electric to hold a pressure-release valve closed under normal pressures and to open the valve rapidly when pressures rise above normal.



ROLLING-SURFACE MECHANISMS

By RALPH A. MORRISON
Mechanical Engineer
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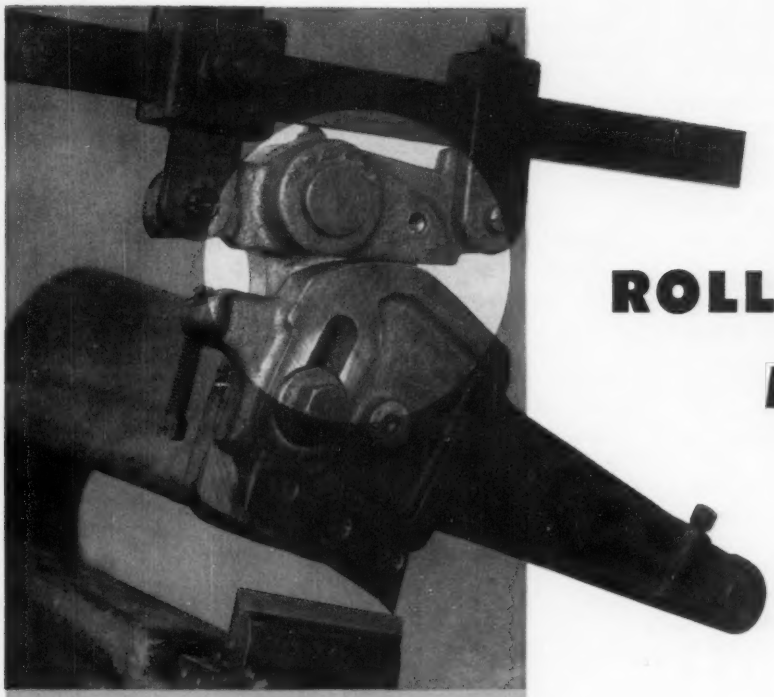


Fig. 1—Rolling surfaces drive . . . this shear since first assembled twenty years ago. To the present, the contacting surfaces still carry the original tool marks

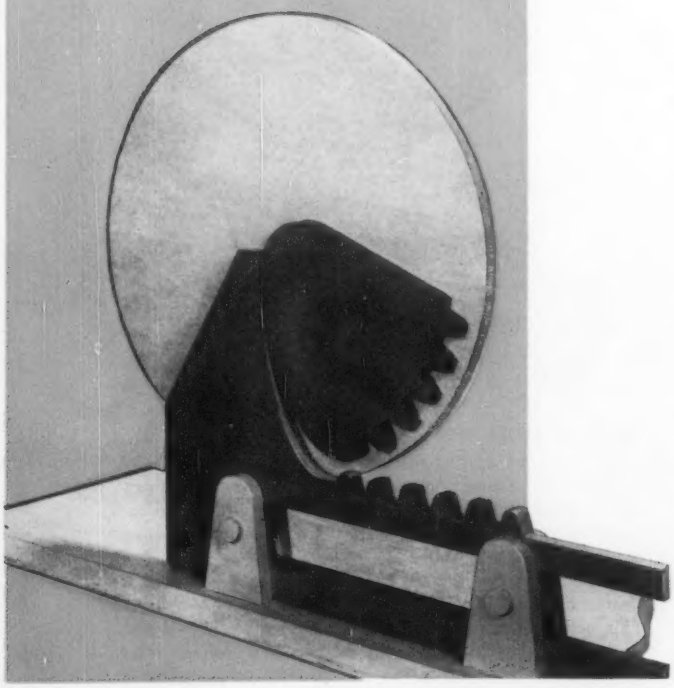


Fig. 2—Rolling surfaces accelerate . . . this rack from rest, then blend into conventional gear and rack teeth which provide uniform rack motion

Need positive, timed starting and stopping of large masses—with acceleration control? This is the job these pure-rolling mechanisms will do with minimum friction and low contact stresses.

Here are general equations, for designing-in any desired acceleration pattern, and specific formulas for so-called parabolic, simple-harmonic, and cycloidal accelerations.

OF THE many mechanisms capable of transmitting power and motion in machines, one that merits appraisal is the rolling conjugate pair, usually called rolling surfaces. Inherent characteristics make rolling surfaces particularly suitable for the acceleration and deceleration of large masses with minimum frictional energy loss. Certain harsh operating conditions, such as the absence of lubricant and the presence of abrasive, are of far less consequence to rolling surfaces than to mechanisms which operate with some degree of sliding action. High load-carrying capacity of rolling surfaces is afforded by low Hertzian contact stresses resulting from large radii of contour curvature.

Curves capable of nearly any desired acceleration characteristic can be determined mathematically. To illustrate this point, and for direct use in design, equations for parabolic, harmonic, and cycloidal characteristics are developed in this article. From sets of these equations, rolling surfaces can be designed to operate like a pair of external gears, a pinion and internal gear, or a rack and pinion drive. Fig. 1 and 2 show representative applications.

It is conceivable that the principles of rolling sur-

faces could be applied in the design of such devices as clutches, buffers, recoil and ramming mechanisms, and movable machine tables. Rolling surfaces have demonstrated their usefulness as a means of linearizing complex functions for recording purposes.* In that case, the problem was to obtain a precise motion of small masses without the disturbing influences of sliding friction and lost motion—however slight—of a conventional linkage. Similar applications occur in modern computers.

Like all other mechanisms, however, rolling surfaces have limitations. Foremost is the lack of positive control of the driven member. That is, to prevent separation and loss of timing during the deceleration of a mass, the deceleration forces must always exceed the work forces. Thus, both applications and motion characteristics must be carefully matched to preclude this possibility. However, in many applications, only the accelerating surface would be used, then followed by gear teeth or other positive driving means.

To establish the functional details of rolling surfaces, Table 1 presents design equations in general form and also in forms which produce parabolic, simple harmonic, and cycloidal motion. The equations are expressed in polar co-ordinates, and they proceed from the initial consideration that output displacement is a function of input displacement, $\theta_2 = f\theta_1$. The following remarks and Fig. 3 complement the table.

Pressure Angle: Designated β, pressure angle is the angle between a normal to a curve and the direction of motion. It is also the angle between the radius vector and the tangent to a curve. In general form, the equation for β is

$$\beta = \tan^{-1} \frac{r\,d\theta}{dr}$$

Normal Force: For the force, F, normal to surfaces in contact, the general equation is

$$F = \frac{T_1}{r_1 \cos \beta} = \frac{T_2}{r_2 \cos \beta}$$

Radius of Curvature: Contact stresses between mating surfaces must be determined to evaluate the surface endurance of the materials involved. For this purpose, the radii of curvature of both bodies are required for substitution in the Hertz equation. Radius of curvature can be determined graphically or by calculation. Values of either r_1 or r_2 can be substituted in the equation

$$R_c = \frac{\left[r^2 + \left(\frac{dr}{d\theta} \right)^2 \right]^{3/2}}{r^2 + 2\left(\frac{dr}{d\theta} \right)^2 - r\frac{d^2r}{d\theta^2}}$$

Ratio of Maximum Velocities: Ratios of angular displacements can be established to obtain fixed ratios of maximum velocities. When the maximum radius of

Nomenclature

C = Center distance between cams
F = Force normal to surfaces in contact
L = Total linear displacement of driven rack at angle α on driver
M = Gear ratio; Ratio of maximum velocities
R_c = Radius of curvature
r = Radius vector at angle θ
T = Combined acceleration and work torques applied to surfaces
x = Linear displacement of driven rack at angle θ_1 on driver
α = Total angular displacement of driver
β = Pressure angle
γ = Total angular displacement of driven
θ = Angular displacement

Note: Subscripts 1 and 2 pertain to driver and driven members, respectively.

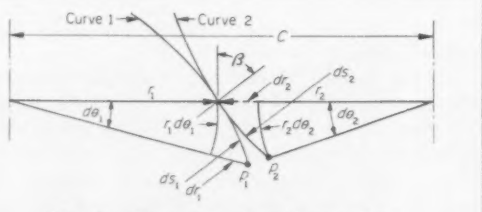


Fig. 3—Elements of rolling action

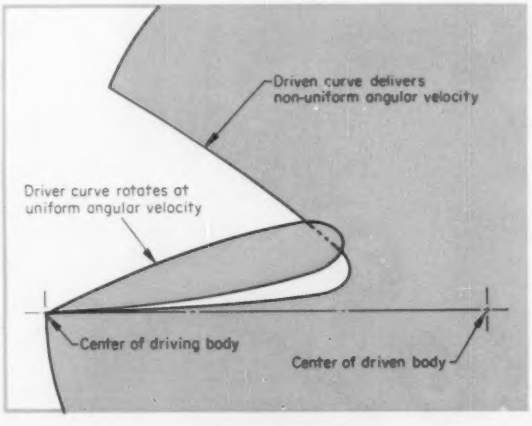

Driven curve delivers non-uniform angular velocity
Driver curve rotates at uniform angular velocity
Center of driving body
Center of driven body

Fig. 4—External rotating contours . . .

convert uniform angular motion of this driver into cycloidal motion at the driven. Interference occurs between these particular curves if the deceleration half of each is used. Elimination of interference is treated under that head in the adjoining text.

It also occurs that β starts at 0 deg and increases gradually. Near the end of acceleration, β increases rapidly to 90 deg. This performance is a limitation of these curves. However, it can be shown that β_{max} can be held to a practical value by utilizing only parts of the curves. The calculated β of this design, at the point of maximum acceleration, is only 9 deg, 20 min.

These curves lend themselves to high load-carrying capacity not only because of rolling action, but also because of the large enveloping radii of curvature.

*F. W. Hannula—"Designing Noncircular Surfaces," MACHINE DESIGN, Vol. 23, No. 7, July 1951, Page 111.

Table 1—Equations for Design Features of Rolling Surfaces

	General	Parabolic	Simple Harmonic	Cycloidal
Radius Vectors				
External driver—External driven: $r_1 =$ $r_2 = C - r_1$	$\dfrac{C}{1 + \dfrac{d\theta_1}{df(\theta_1)}}$	$\dfrac{C}{1 + \dfrac{1}{2K\theta_1}}$	$\dfrac{C}{1 + \dfrac{1}{\dfrac{K\gamma}{2}\sin K\theta_1}}$	$\dfrac{C}{1 + \dfrac{1}{\dfrac{K\gamma}{2\pi}(1 - \cos K\theta_1)}}$
External driver—Internal driven: $r_1 =$ $r_2 = C + r_1$	$\dfrac{C}{\dfrac{d\theta_1}{df(\theta_1)} - 1}$	$\dfrac{C}{\dfrac{1}{2K\theta_1} - 1}$	$\dfrac{C}{\dfrac{1}{\dfrac{K\gamma}{2}\sin K\theta_1} - 1}$	$\dfrac{C}{\dfrac{1}{\dfrac{K\gamma}{2\pi}(1 - \cos K\theta_1)} - 1}$
External driver—Driven rack: $r_1 =$	$\dfrac{df(\theta_1)}{d\theta_1}$	$2K\theta_1$	$\dfrac{KL}{2}\sin K\theta_1$	$\dfrac{KL}{2\pi}(1 - \cos K\theta_1)$
Output Displacement, θ_2				
External driver—External or internal driven: During acceleration		$K\theta_1^2$	$\dfrac{\gamma}{2}(1 - \cos K\theta_1)$	$\dfrac{\gamma}{2\pi}(K\theta_1 - \sin K\theta_1)$
During deceleration		$\gamma - K\theta_1^2$	same	same
Output Displacement, x				
External driver—Driven rack: During acceleration		$K\theta_1^2$	$\dfrac{L}{2}(1 - \cos K\theta_1)$	$\dfrac{L}{2\pi}(K\theta_1 - \sin K\theta_1)$
During deceleration		$L - K\theta_1^2$	same	same
During both x displacements, $K =$		$\dfrac{2L}{\alpha^2}$	$\dfrac{180 \text{ deg}}{\alpha \text{ deg}}$	$\dfrac{360 \text{ deg}}{\alpha \text{ deg}}$
Pressure Angle, β				
External driver—External driven	$\tan\beta = \left[\dfrac{df(\theta_1)}{d\theta_1} + \left(\dfrac{df(\theta_1)}{d\theta_1}\right)^2\right] \Big/ \dfrac{d^2f(\theta_1)}{d\theta_1^2}$	$\theta_1(2K\theta_1 + 1)$	$\dfrac{\tan K\theta_1\left(\dfrac{K\gamma}{2}\sin K\theta_1 + 1\right)}{K}$	$\dfrac{(1 - \cos K\theta_1)\left[\dfrac{K\gamma}{2}(1 - \cos K\theta_1) + 1\right]}{K \sin K\theta_1}$
External driver—Internal driven	$\tan\beta = \left[\dfrac{df(\theta_1)}{d\theta_1} - \left(\dfrac{df(\theta_1)}{d\theta_1}\right)^2\right] \Big/ \dfrac{d^2f(\theta_1)}{d\theta_1^2}$	$\theta_1(1 - 2K\theta_1)$	$\dfrac{\tan K\theta_1\left(1 - \dfrac{K\gamma}{2}\sin K\theta_1\right)}{K}$	$\dfrac{(1 - \cos K\theta_1)\left[1 - \dfrac{K\gamma}{2\pi}(1 - \cos K\theta_1)\right]}{K \sin K\theta_1}$
External driver—Driven rack	$\tan\beta = \dfrac{df(\theta_1)}{d\theta_1} \Big/ \dfrac{d^2f(\theta_1)}{d\theta_1^2}$	θ_1	$\dfrac{\tan K\theta_1}{K}$	$\dfrac{1 - \cos K\theta_1}{K \sin K\theta_1}$
Ratio of Maximum Angular Velocities, M (Rotating pairs)	$\dfrac{r_{1\max}}{C \pm r_{1\max}}$	$\dfrac{2\gamma}{\alpha^2}$	$\dfrac{\pi\gamma}{2\alpha}$	$\dfrac{2\gamma}{\alpha}$
Constant, K Except in parabolic output displacement, x		$\dfrac{2\gamma}{\alpha^2}$	$\dfrac{180 \text{ deg}}{\alpha \text{ deg}}$	$\dfrac{360 \text{ deg}}{\alpha \text{ deg}}$

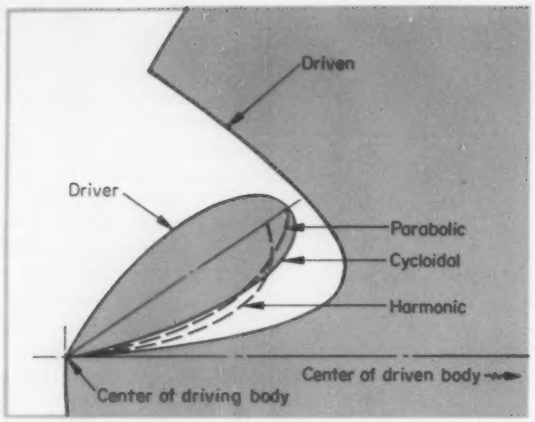


Fig. 5—Similar external contours . . .
have a ratio of angular displacement of approximately 2 to 1 to avoid interference on the trailing surfaces. This design permits a complete cycle and returns the driven mass to rest through cycloidal deceleration provided the working torque does not exceed the deceleration torque.

Dashed lines show the shapes of drivers which have parabolic and harmonic acceleration characteristics. Note that on the parabolic curve, the pressure angle does not approach 90 deg at the end of acceleration.

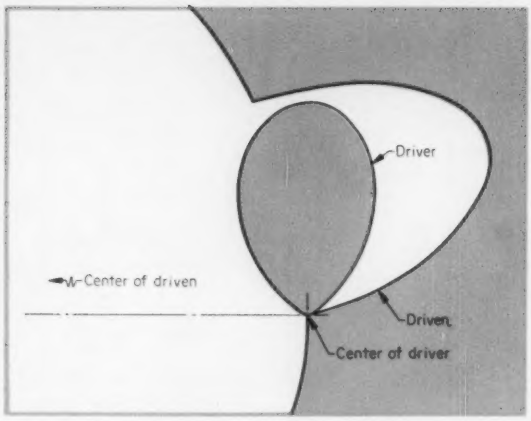


Fig. 6—External driver and internal driven . . .
are so shaped that driven displacement of 30 deg is produced from 180-deg driver displacement. This performance accounts for the pronounced egg shape of the driver. With 360-deg motion, the driver would be heart shaped. In the design of internal drives of this type, it has been found that the outside radius of the driver increases very rapidly as the angle of action decreases. This is a general limitation of internal drives.

the driver is blended with the pitch line of a gear, that driver radius is fixed by the desired gear ratio. Since the gear ratio, M, is equal to the ratio of pitch radii, it is also equal to the general ratio in Table 1. The ratios for parabolic, simple harmonic, and cycloidal motions, Table 1, are derived from the general expression.

The equations for parabolic and cycloidal motions show that a ratio of 2 to 1 for angular displacements is required to obtain a final gear ratio of 1 to 1 at the completion of acceleration.

Eliminating Interference: As noted in Fig. 4, an interference between trailing surfaces can exist if the complete cams have certain displacement ratios. To avoid interference, the ratio of displacements must be such that r_{1max} is equal to or smaller than a chord across the opening of the driven member, that is,

$$\gamma = 2 \sin^{-1} \frac{r_{1,\,max}}{2C}$$

For cycloidal output motion, as an example,

$$r_{1,\,max} = \frac{C}{1 + (\alpha/2\gamma)}$$

Let $\alpha/\gamma = M$, then

$$\frac{\gamma}{2} = \sin^{-1} \frac{1}{2 + M}$$

$$M = \csc \frac{\gamma}{2} - 2$$

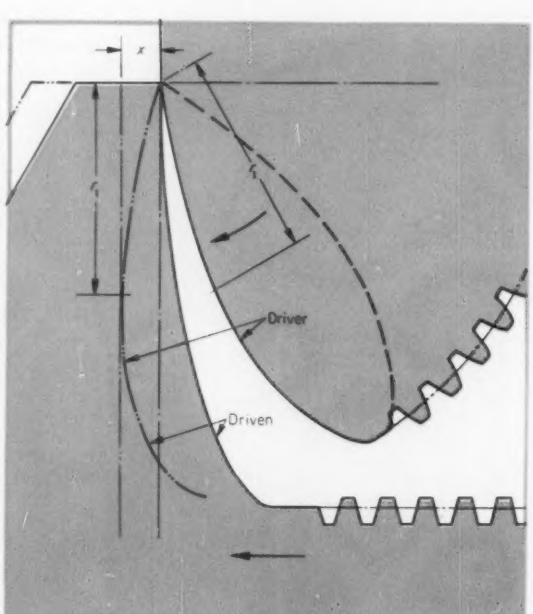


Fig. 7—External driver and driven rack . . .
are shown at the beginning of acceleration. Until the driver approaches this position, the rack does not move. Further clockwise motion of the driver causes cycloidal acceleration of the rack until the gear teeth engage the rack teeth. As is the case with all rolling curves, the length of the acting profiles are identical. The locus of the point of contact has the rectangular co-ordinates x (horizontal) and r_1 (vertical) shown.

Using Rectangular Co-ordinates: For many applications where operating speeds and loads are not excessive and where the highest accuracy is not

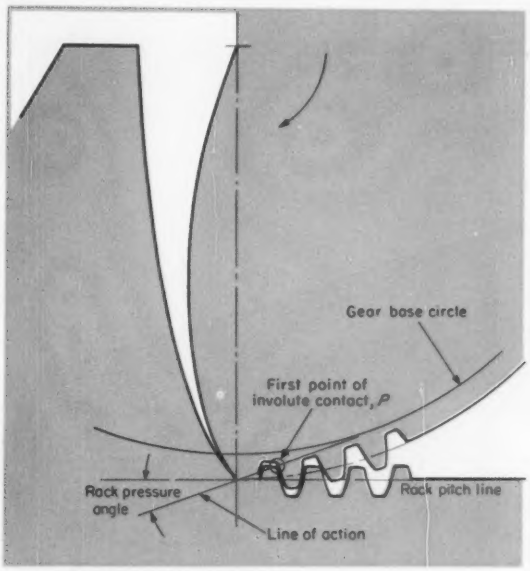


Fig. 8—Modified external driver and rack . . . are shown at the end of acceleration. The maximum pressure angle has been limited by blending the gear teeth at the point of maximum desired pressure angle on the driver. This arrangement results in a minor modification of the motion characteristics at the end of acceleration, as shown in Fig. 9.

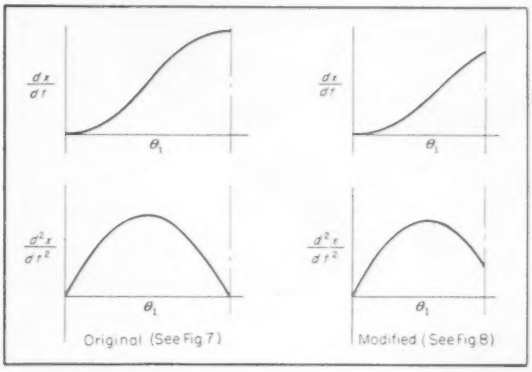


Fig. 9—Effects of driver and rack modification . . . are shown in these curves. By adjustment of the theoretical maximum outside radius of the driver, the gear teeth can be generated on any convenient diameter, and the maximum cam pressure angle will be limited to a value desired. Fig. 8 illustrates the method of blending gear teeth to the cam curves. As shown there, the teeth are positioned so that the first point of involute contact, P, on the line of action of the gear, occurs at the position of last point of contact between cam surfaces. Then, with the rack pressure angle and the rack addendum known, the positioning of the gear teeth is determined by trigonometric procedure.

required, the curves can be manufactured from templates. However, where the dynamics of the system are of prime importance and the highest accuracy is required, it is preferable to mill the cam according

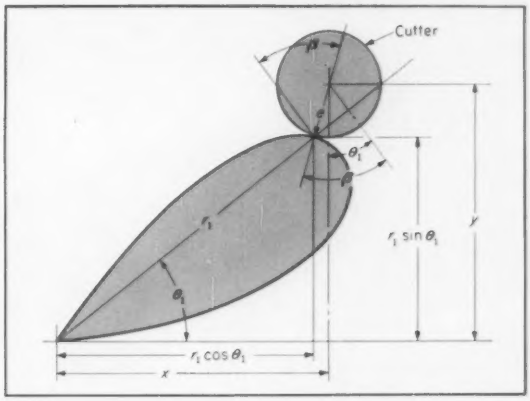


Fig. 10—Rolling surface details . . . should be specified in rectangular co-ordinates to obtain maximum accuracy and corresponding performance. Alternate practice is manufacture from templates.

to rectangular co-ordinates calculated as in Fig. 10. Co-ordinates for the center of the cutter are

$$x = r_1 \cos \theta_1 + e \sin (\beta - \theta_1)$$

$$y = r_1 \sin \theta_1 + e \cos (\beta - \theta_1)$$

where e = cutter radius, and β = pressure angle. The same equations for x and y are applicable to the mating curves if r_2 and θ_2 are substituted for r_1 and θ_1.

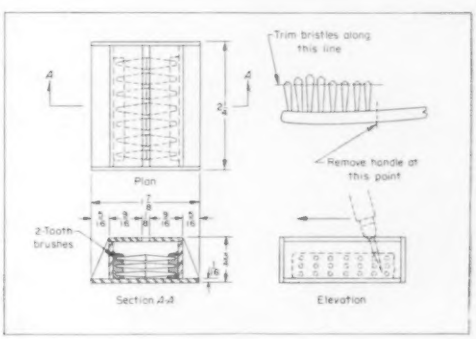
Tips and Techniques

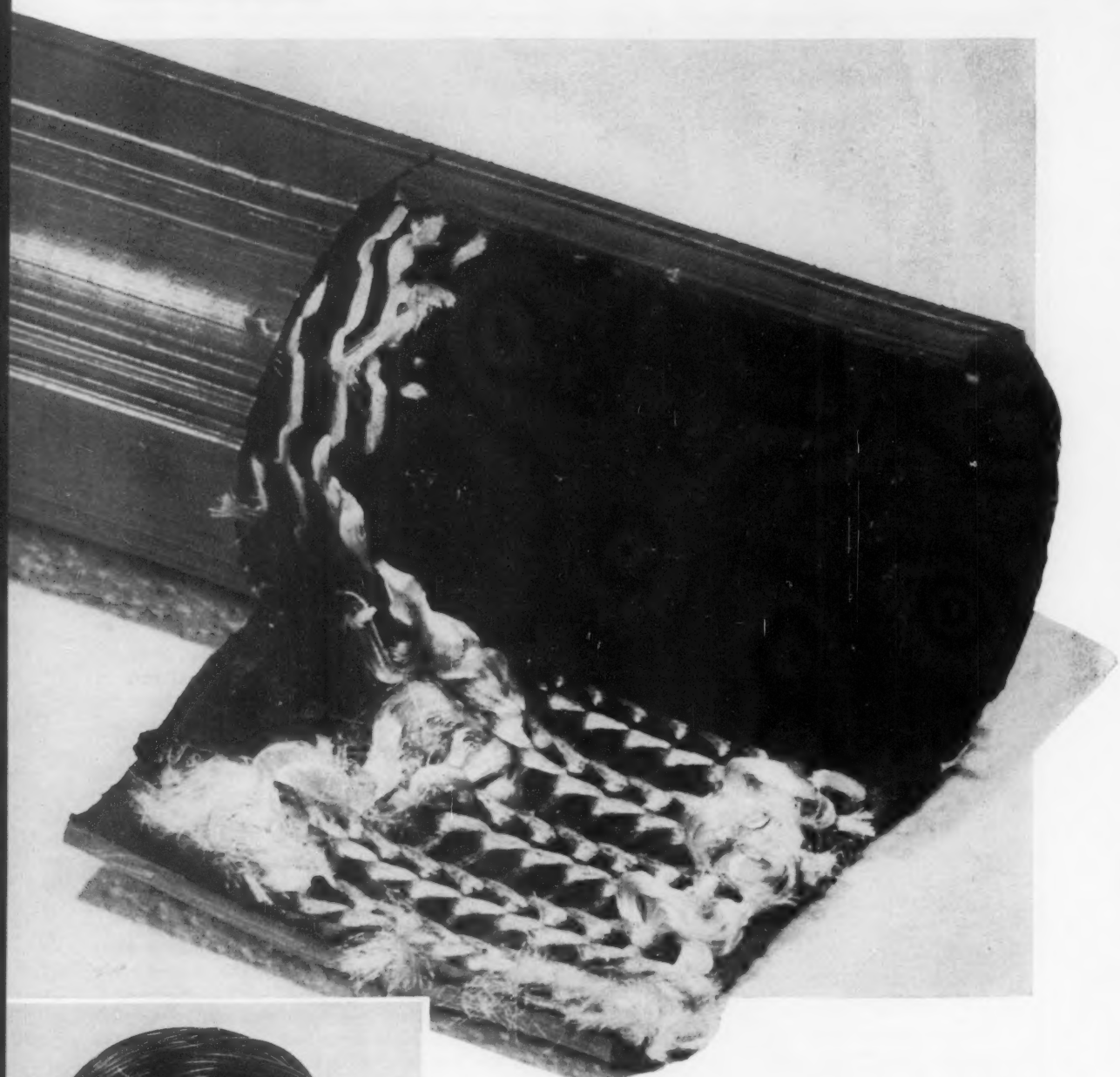
Pencil Cleaner

Excess graphite can be quickly removed from pencil points after sharpening by this cleaner made from tooth brushes.

The bristles are trimmed even, and the brush heads are mounted in a shell of 1/16-in. plastic, with the bristles of each head in contact. A $\frac{1}{8}$-in. slot in top of shell provides an insert for pencil.

After the pencil is sharpened, the point is inserted in the slot and run through the bristles which neatly remove the graphite.—Dale H. Johnson, *Midland, Mich.*





An adhesive bond strong enough to tear the embedded rayon cord out of the rubber hose is formed by a nitrile-rubber adhesive. The dried adhesive is reactivated by heat of the extruded vinyl covering. Automatic application of a rubber-base adhesive to the core of the fuel-hose assembly, left, permits economical production of the hose. Cotton braid is bonded to the core and lacquered.

- Advantages of bonding
- Types of rubber-base adhesives
- Joint design
- Adopting bonding methods

Designing

Bonded Rubber Assemblies

By R. K. HUMKE
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ADHESIVE bonding is the most practical and economical method of joining rubber to rubber or rubber to metal, plastic, wood, and other materials. The adhesive allows stresses to be distributed uniformly over an entire joint area. This results in joints of greater strength than those made with mechanical fasteners and it also permits use of thinner rubber stock.

Elasticity of the bond, particularly of a bond made with an elastomeric (rubber base) adhesive, absorbs some of the stresses created by flexing, vibration, and differences in coefficients of thermal expansion of the materials joined. Also, weight of the adhesive required is usually less than that of mechanical fasteners. Adhesives allow fabrication of complex assemblies which might not be possible with other joining methods. Almost any adhesive compound can be applied in a variety of ways which are adaptable to production assembly set-ups. Separation of joined parts for replacement or repair can be accomplished by application of heat or solvent without appreciable damage to the rubber.

Bonding of rubber assemblies is most efficiently achieved with elastomeric adhesives which have unique properties and are ideally suited for numerous bonding applications. Solvent-release type elastomeric adhesives form strong bonds immediately after assembly and thus eliminate the necessity for heat, clamps, or other means of effecting a joint. These adhesives are able to support at least a moderate load immediately after application. In addition, because of their flexibility or ability to form nonrigid bonds, elastomeric adhesives are exceptionally resistant to vibration and flexing and are able to withstand sudden extreme changes in temperature. These adhesives flex and stretch under stress and, unless the elastic limit is exceeded, recover when the load is removed.

Thermoplastic elastomeric adhesives have excellent peel and cleavage strength compared to other adhesive types. These properties are very necessary in an adhesive used to bond rubber to rubber, or rubber to other adherends, since peel and cleavage stress conditions are set up in the joint when the rubber stretches, bends, twists, or deforms under high load conditions.

Composition-wise, elastomeric-type adhesive bases are made from practically all the natural and synthetic rubbers as well as new and reclaimed rubbers. The large number of adhesives of this type which are available for bonding rubber to a variety of adherends contains all the common types of rubbery polymers available today as, for example, nitrile, neoprene, and GR-S compounds. Most rubber-base adhesives are thermoplastic and soften at a slow rate with increasing temperature. However, they never melt completely but remain viscous and sticky until they decompose. Types and applications of thermoplastic and thermosetting rubber-base adhesives will be covered in a forthcoming issue of MACHINE DESIGN.

In commercial practice, almost all elastomeric

type adhesives are modified with additives, either thermoplastic or thermosetting, such as resins, elastomers, fillers, or vulcanizing agents. These additives can greatly modify such properties as flexibility, strength, heat and cold resistance, exposure resistance, dead-load strength, peel strength, and other characteristics.

Selecting the Adhesive

Because many types of elastomeric adhesives are available today, several important factors must be considered before selecting one for a specific assembly application.

Compatibility: Determine the type of adhesive that will stick to the base materials. Successful bonding of rubber to rubber or rubber to other materials depends on the compatibility of the adhesive with both surfaces.

Chemical composition of the adhesive chosen should then be investigated to make sure that it does not contain any solvents or modifiers that are harmful to the adherends. Some adhesives of a particular class may contain solvents that will soften the adherends and reduce adhesion and bond strength or cause a chemical reaction between adhesive and adherend which produces undesirable byproducts. For almost every application, there are adhesive formulas available in the classification chosen that will not react with the adherends. For example, if an adhesive solvent reacts with the adherends, a water-dispersed adhesive or one that is cured chemically or by heat can be substituted.

In bonding dissimilar materials, perhaps only one of the adherends may be affected by the solvent in the adhesive. Then, it may be possible to apply the adhesive to the surface of the adherend that is not affected and let the solvent evaporate. The two adherends can then be bonded by reactivating the adhesive with heat. This is easily accomplished with thermoplastic elastomeric adhesives.

Bonding methods for the adhesive selected should be checked to insure that the adherends will not be affected by the procedures. For example, if the adherends will soften or decompose under heat and pressure, then another adhesive type should be selected. In this case, a contact-bonding adhesive can be used which will adhere to the adherends with sufficient strength without requiring heat and pressure.

If relatively weak or low-strength adherends are to be bonded, such as felt to rubber, then an adhesive of higher strength than the felt should be chosen. Thus, the adherend will fail before the adhesive if the assembly is overloaded.

Service Conditions: Types and magnitudes of stress that the bond will be required to sustain and its resistance to deterioration must be considered as influencing the choice of adhesive. Other factors which contribute to final selection include peel strength, shear strength, dead-load shear strength, tensile strength, fatigue strength, bend strength, rate of load application, temperature extremes, working temperatures, types of exposure, solvents, humidity, salt spray, corrosion, and vibration. A suitable adhesive must have adequate strength to hold the bonded assembly together for the life of the assembly, and to maintain that strength under service conditions.

Thermoplastic elastomeric adhesives produce elastic bonds and exhibit high peel strengths but relatively low tensile and shear strengths. Because these adhesives are flexible and form nonrigid bonds, they are often selected for applications where vibration, flexing, impact loads, and sudden changes in temperature are encountered.

Adhesive film thickness has an influence on peel and impact strength requirements. When selecting a thermoplastic adhesive for this condition, it should be noted that the greater the film thickness the higher the peel strength. Elastomeric adhesives are superior where peel strength is an important consideration because, in stretching under stress, they tend to widen the line along the load carrying edge, thus distributing the load over a greater area.

Thermoplastic elastomeric adhesives are ideal for bonding dissimilar adherends which have greatly different coefficients of expansion. A rigid adhesive develops high internal stresses as changes in temperature occur and, in many instances, the stresses are great enough to destroy the bond or warp the assembly. These adhesives, which stretch under load, return to normal when the adherends resume

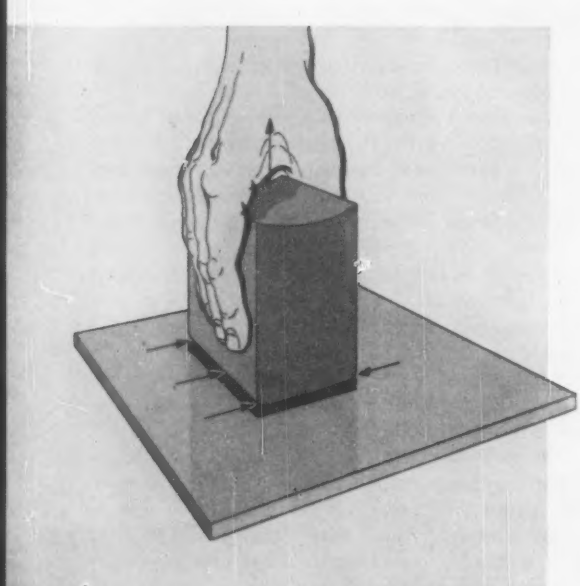


Fig. 1—Forces acting on an adhesive joint as a result of a tensile load applied to the rubber adherend. The plate is nonflexible. Stresses will not remain perpendicular to the joint, since the rubber adherend deforms under increasing load. Cleavage and peel stresses develop as a result of joint deformation.

normal dimensions.

Rubber-base thermosetting adhesives are more rigid than thermoplastic adhesives and produce bonds that have high tensile and shear strengths. Thermosetting adhesives are also more applicable where resistance to high stress for long periods of time is required.

All adhesives lose some strength at elevated temperatures, but the thermoplastic elastomeric adhesives lose most of their strength. However, they retain some of their properties until they decompose.

Resistance to deterioration of the adhesive by environmental attack is also an important consideration in selection of the adhesive. Exposure of the bonded assembly to solvents, water, chemicals, humidity, fuels, acid solutions, atmospheric conditions, oil, hydraulic fluid, and other deteriorating media can change the strength properties of the adhesive. Rubber-base adhesives, most of which are resistant to some of these media, should be chosen with regard to the most deteriorating condition in the proposed application. Resistance to all corrosive media cannot be found in any one adhesive. Some are not affected seriously enough to impair usefulness for a given application.

Economies: An elastomeric adhesive formulation which is selected on the basis of closely meeting assembly requirements should also be one that can be applied practically and economically. Some requirements that should be considered are: Application equipment, bonding temperature and pressure, bonding time, and rate of strength buildup of the adhesive.

For example, consider the problem of bonding a large, rubber component to a similarly large plastic component. The plastic component is of such composition that it will deform under heat and pressure. Also, assembly at high production rates is required. Selection of an adhesive in this particular case should be one that will produce a bond of required strength immediately after assembly without using heat or pressure. Also, because of the size of the components and production rate, the adhesive should be one that can be applied by spraying to minimize application time. Selection in this case would be a solvent-release type elastomeric adhesive which produces strong bonds immediately after assembly with a rapid rate of strength buildup. Many solvent-release type adhesives exhibit good tack properties while still containing a considerable amount of solvent. In this sample application, however, the adhesive selected would have to contain a solvent that does not attack the plastic adherend.

In general, the method by which the adhesive is applied is related to required production rate, part size, part shape, and the relationship between the area to be coated and geometry of the part. Application equipment depends on its practicability, availability, and cost. Many different elastomeric adhesives are available with different consistencies, viscosities, and properties for different application methods. Bonding pressure and temperature are usually determined by the properties of the materials to be joined. Elastomeric adhesives vary from solvent-solution contact-bonding types to types requiring heat and pressure to complete the bond.

The most economical adhesive is the one that has the required properties for the job plus the adaptability to be applied by existing or low-cost assembly equipment. Cost of an adhesive, therefore, cannot be considered on a price-per-pound basis but must include end product properties, material costs, labor, capital expenditures for jigs and bonding equipment, and other factors which may affect production and sale of the product. Specific applications should be studied to determine which of these factors is most important and limiting. Two or more adhesives of the type desired should then be tested under actual or simulated service conditions to determine actual bond strengths.

Joint Design

Thermoplastic elastomeric adhesives generally have low tensile and shear strengths. However, because of film elasticity, they develop high peel and cleavage strengths which are necessary if the joint is subjected to high loads. Under high-load conditions, rubber adherends stretch, bend, twist, or deform and induce peel or cleavage stress in the joint. Although these adhesives have good cleavage and peel strength properties, joints should be designed for shear wherever possible.

Adhesives such as neoprene phenolics and nitrile phenolics have high shear and tensile strengths due to resin additives. However, these cause some loss in bond elasticity. Regardless of whether these adhesives are used for low or high stress conditions, the following basic rules for joint design apply.

Types of Loading: All joints should be designed so that their geometry is conducive to maximum strength. Greatest strength is obtained when the maximum bonded area is put to work by stressing the joint in the direction of maximum strength.

It is desirable to design a joint for tensile and shear stresses since these bring the entire adhesive film into play for the greatest strength. Next, in order of preference from a strength standpoint, is the joint designed for cleavage stresses. A third type, the peel-loaded joint, utilizes only the edge of the adhesive film and has the lowest strength of the three.

Tensile Strength of Joints: Rarely, if ever, is a joint achieved in which the stresses are entirely pure tensile, shear, cleavage, or peel. In practice, there is usually a combination of several types of stresses, and each joint must be carefully designed if maximum strength is necessary. The ideal joint, loaded in either tension or shear, is equally rare in an assembly because either one or both of the adherends will stretch under these conditions.

In a rubber assembly loaded entirely in tension, stresses are perpendicular to the plane of the joint, Fig. 1. Tensile stress is distributed uniformly over

the entire area, and the whole joint is stressed at the same moment with all of the bond reacting. However, two conditions can occur while the joint is under tension: Either the stresses will not remain perpendicular to the plane of the adherends, or one or both of the adherends will bend, twist, or stretch.

In either case, it is possible for these forces to resolve themselves into cleavage or peel stresses. For example, if a rubber block bonded to a steel plate is loaded in tension which tends to pull it away from the plate, the edges of the block take the initial stress and the block deforms. As deformation progresses, there develops a condition resembling cleavage and the load finally produces a condition which closely resembles that found in peel loading. This is essentially what happens when rubber adherends are tensile stressed unless they are rigid or heavy enough in cross section to resist deformation.

Joint Shear Strength: In a shear-loaded joint, stress direction is parallel to the plane of the joint and stress is uniformly distributed. If the adherends are susceptible to stretch or elongation while under shear, they will deform until the adhesive-bond alignment is in better conformance with the direction of loading. As stress increases, the rubber deforms and the edges are subjected to some peel stress and are more susceptible to failure.

For example, if two strips of rubber are bonded and shear loaded, the rubber stretches readily between its points of attachment and the edges of the joint become overloaded. The central portion of the bond is hardly loaded at all initially. As the adhesive along the edges fails, the areas of failure progress inward toward the center until the whole joint fails. At no time is all of the adhesive in the joint given an opportunity to contribute to total joint strength. The edges carry a disproportionate share of the load. Increasing the width of the overlap will not necessarily increase shear strength of the joint. Strength increases to a maximum where the adherends start to yield and progressive failure is inevitable.

Joint Cleavage Strength: In a cleavage-loaded joint, one side is under great stress while the other side is under no load at all. Theoretically, unit stress increases from zero on one side to the cohesive strength limit of the adhesive on the other side. Therefore, not all of the adhesive in the joint is contributing its share of strength and the joint cannot be as strong as a joint of comparable area under tensile or shear loading.

Peel Strength: Peel loading is the least favorable condition of all from the standpoint of strength. All of the stress in a joint of this type is concentrated along a fine line at the very edge of the joint under load, and most of the adhesive is under no stress at all, Fig. 2. This small portion of the total bonded area cannot support more than a fraction of the load which would normally be supported by the joint if it were properly distributed. All joints should be designed to take full advantage of the adhesive properties.

Butt and Lap Joints; Stiffeners: Where cleavage and peel stresses cannot be avoided, the joint should be designed with stiffeners, overlaps, caps, etc. to provide a minimum of these stresses in the adhesive. In many instances, adding stiffeners and overlaps permits use of low tensile and shear-strength adhesives in many applications rather than more expensive, high-strength adhesives.

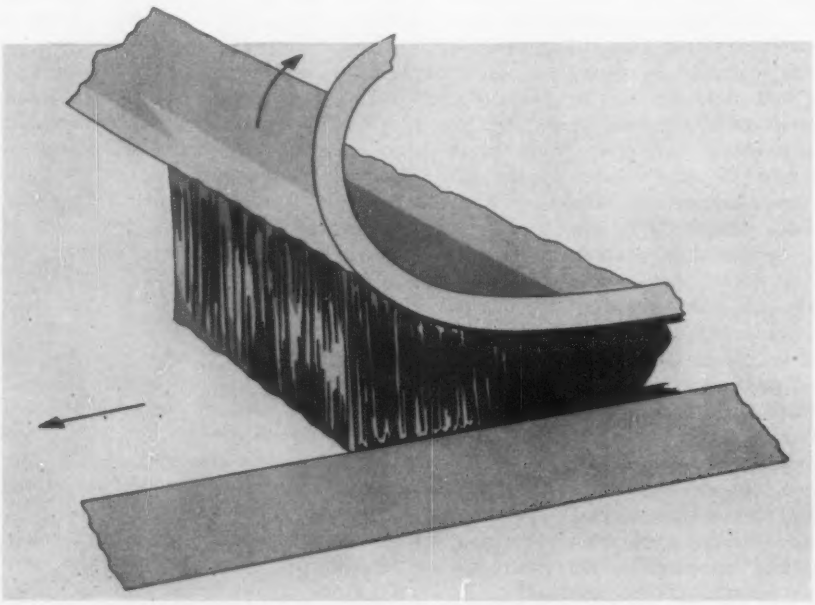


Fig. 2—Peel loading an adhesive bond. This type of loading is the least desirable from a strength standpoint since stress is concentrated at the very edge of the bond. Most of the joint is under no stress at all.

Thin rubber sheets can be bonded in a lap joint or butt joined. However, in the latter case, a strap or doubler of the same material should be applied over the seam. Adhesives normally do not lend themselves to a butt-joint design. Where two rods are butt joined, for example, bending can, through leverage, exert tremendous cleavage forces on the joint and can easily cause failure. However, if the butt joint design is loaded only in tension, the joint will be satisfactory. Scarf joints have been found to be most practical for rubber assemblies.

Reducing Bond Failure: In instances where rubber is bonded to an adherend with a different modulus of elasticity, uniform stresses in the bond can be achieved by tapering one of the adherends symmetrically over the length of the scarf joint in proportion to the modulus of elasticity.

Often, increasing rubber adherend hardness will reduce adhesive failures in assemblies that permit stress to be transmitted through the rubber to the adhesive. This improves stress distribution of the rubber at the adhesive line. Elimination of sharp corners in rubber-metal assemblies also minimizes stress concentration in the adhesive.

Bonding Methods

The best adhesive will produce a poor bond if used on surfaces which are not absolutely free from dirt, grease, oxides, and other foreign materials. When bonding vulcanized rubber, mold release agents may be present on the surface of the molded part which will also result in poor adhesion. Talc and water-soluble mold release agents may be removed with water and plasticizers, and wax may be removed with a solvent.

Improper surface preparation is probably the greatest single cause of adhesive failures. Also, the bonding operation may be complicated if paint or other surface coatings or treatment is used before adhesive is applied. The adhesive may not adhere to the particular coating at all or, even if it does adhere well, the solvent in the adhesive may attack and lift the surface coating to produce a poor joint.

Application of Adhesive: In a few cases, the nature of the adhesive selected may require one particular application procedure. Usually, however, any of several methods can be used. Service requirements and configuration of components joined will indicate which method to adopt.

Brushing and spraying are the most common means of depositing adhesive films. Large areas and complex shapes can be coated economically with adhesives by spraying. Apparatus and spraying techniques are similar to those used for applying paint finishes. Advantages of this method are low labor cost and uniformity of adhesive film. However, rigid control of adhesive viscosity is required. Brushing is used for applying adhesives to a limited number of assemblies, to assemblies of complex shape, or in cases where only part of the surface is to be coated and masking would be impractical. Other methods of applying adhesives require use of oil cans or pressure-fed flow guns, roll coaters for sheet stock, or knife coaters for spreading films of uniform thickness.

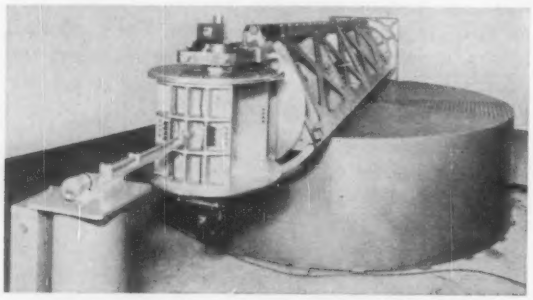
Parts with unusual contours which must have adhesive only on the faces of their projections can be coated advantageously with a stamp-pad device. When only certain areas of a flat surface are to be coated, a silk screen is often used. An adhesive pattern of considerable accuracy can thus be registered on a surface. Heavy bodied, rubber-base adhesives can be applied with a notched trowel which controls the amount applied.

Bond Types: One of the major problems in bonding is to dissipate the solvents so that the adhesive film can develop strength. Solvent is useful only to give consistency for application. Once applied, it is a hindrance and must be released before the adhesive can function. Common bond types for rubber-base adhesives are:

1. *Wet Bonds*: The adhesive is applied to the least porous surface and the other surface is then brought into contact immediately. This method is suitable where one surface is porous enough to permit passage of the solvents.
2. *Tacky Bonds*: The adhesive is applied to one or both surfaces and allowed to dry until an aggressive tack is developed. Open-drying time depends on the type of adhesive, but allowances must be made for temperature, humidity, and ventilation. Once an aggressive tack has developed, the coated surfaces are pressed firmly together. Nature of the adhesive and type of surfaces being bonded determine whether one or both surfaces should be coated. High strengths are generally achieved if both surfaces are coated.
3. *Reactivated Bonds*: If both adherends are impervious to passage of solvent or if the adherend area is large, reactivated bonding is recommended to prevent entrapment of solvents. Surfaces of the adherends are coated and allowed to dry. The adhesive is reactivated by either solvent or heat at the time the bond is made. For heat reactivation, it is possible to precoat the adherend several days or even weeks in advance of bonding if surfaces are protected from dust and dirt. Adherends with the dry films are then assembled and the bond is reactivated by heating in an oven or by other suitable means until the films soften and fuse. Temperature and time required for reactivating depend on the adhesive and materials being bonded. In a solvent-reactivated bond, precoated surfaces are simply wiped with a suitable solvent and the adherends are pressed together.
4. *Pressure-Sensitive Bonds*: Adhesives must be used that will retain their tack for long periods of time. After the solvent has evaporated from the adhesive, the tacky surfaces are pressed together under contact pressure. This is a simple procedure but, unfortunately, there are very few adhesives that meet this tacky requirement.
5. *Cured Bonds*: With some rubber-base adhesives, curing develops maximum strength. Adhesives in liquid form are usually cured by heat, pressure, or by addition of an accelerator. In many instances, these adhesives are 100 per cent nonvolatile although some do contain a volatile liquid for easy application.

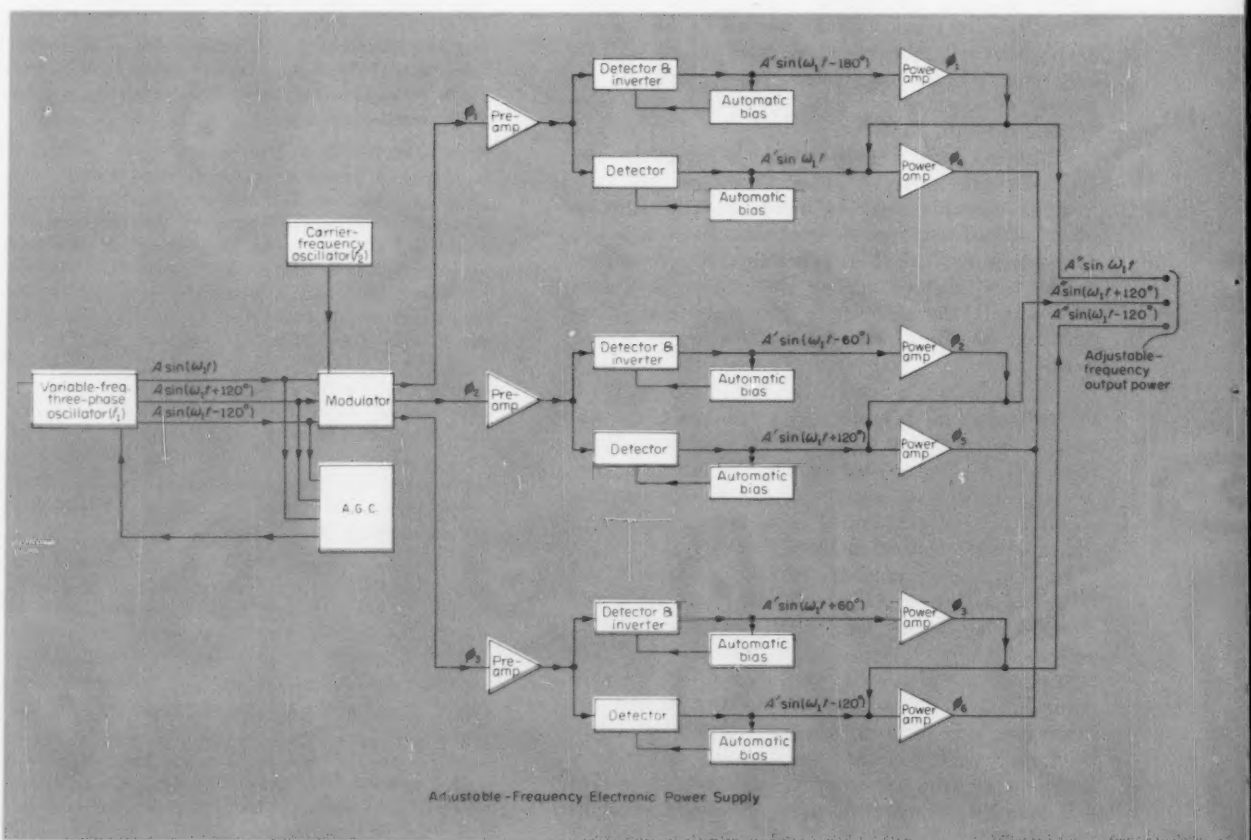
Crystal Controls Motor Speed

ROTATIONAL DRIVE SPEED of a three-phase electric motor is controlled to within 1 part in 400,000 by an external crystal oscillator. As reported by design engineer Jerome Linn, Genisco Inc., Los Angeles, the drive system is built around an eight-pole, three-phase synchronous motor. The drive system is so accurately regulated that drift rate in speed is less than 1 part in 10 million per week.



The drive system was designed to rotate a 20-ft diameter ultraprecise centrifuge built for Arma Div., American Bosch Arma Corp., and AC Spark Plug, General Motors Corp. The centrifuge subjects extremely sensitive inertial-guidance components to an environmental gravitational field which can be determined to a precision of 1 part in 100,000.

ADJUSTABLE-FREQUENCY INPUT POWER to the synchronous motor is supplied from a three-phase electronic supply which controls the output of three rotary amplifiers. The electronic power supply is infinitely adjustable in frequency from 0.33 to 7 cps, giving a motor speed range of 6 to 100 rpm. Voltage requirements are a function of frequency and vary from 5 v at minimum



Adjustable-Frequency Electronic Power Supply

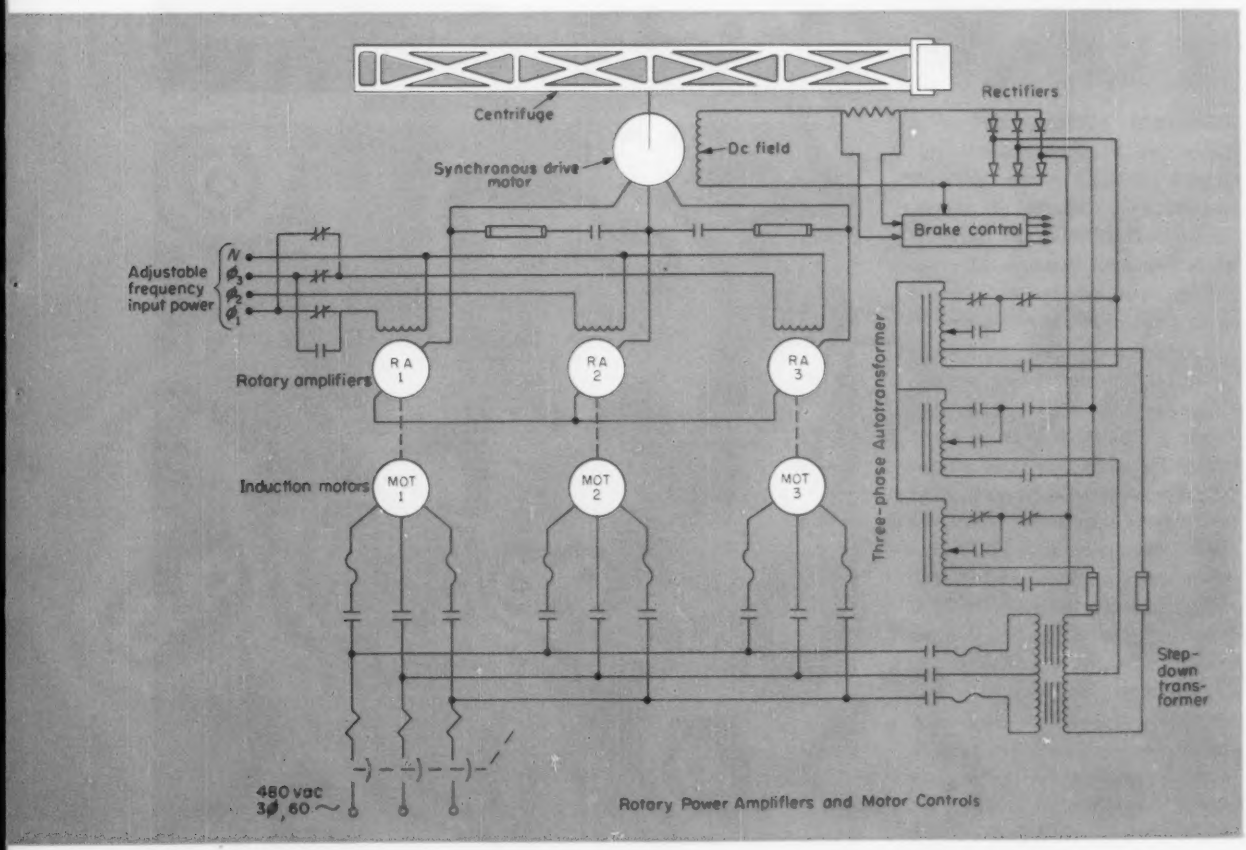
To 1 Part in 400,000

speed to 26 v at maximum speed. Maximum output current of the supply is 200 amp. The motor delivers 350 lb-ft of torque at 100 rpm and accelerates synchronously from 6 to 100 rpm.

The three-phase oscillator developed for the precision frequency source is based upon an RC phase-shift network that is resistance tuned by a three-gang, 15-turn potentiometer. Maximum frequency stability is achieved by closely regulating plate, cathode, and filament voltages. Bias voltage is established by a mercury cell. Output amplitude is maintained by an automatic gain-control system which effects slight variations in plate voltage. Since the oscillator requires maximum temperature stability, the unit is enclosed in a heavy copper heat sink with a mild-steel liner sunk below floor level within the environmental chamber enclosing the machine.

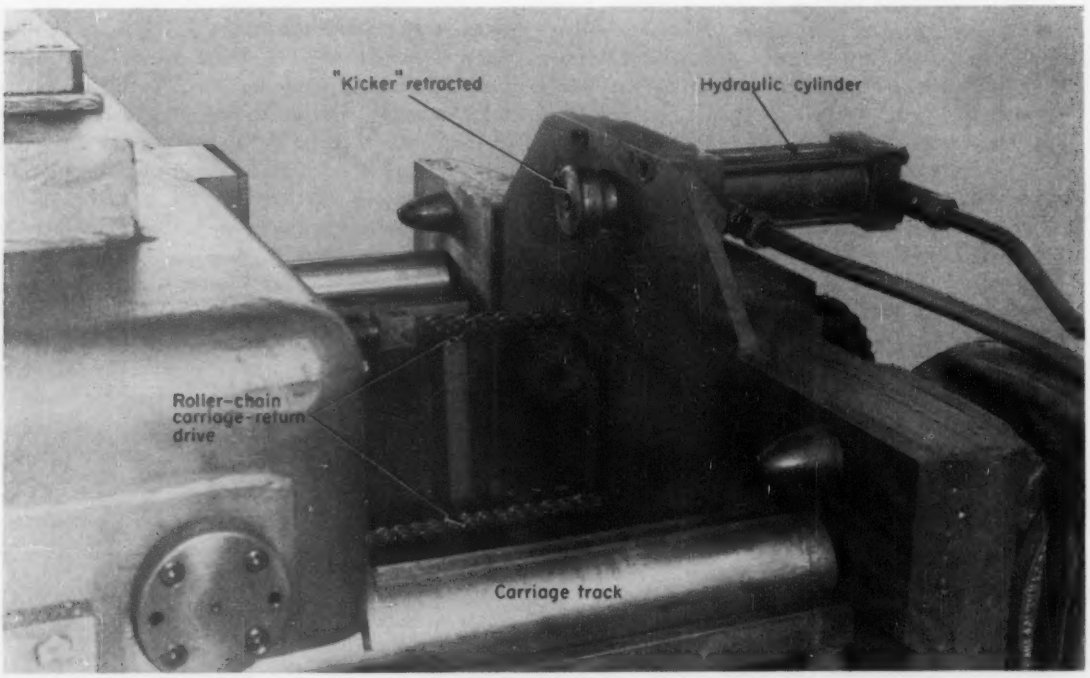
FINAL POWER AMPLIFICATION is accomplished by three rotary amplifiers, each of which consists of a single-phase commutated generator driven by a three-phase, 440-v, 60-cycle induction motor. The rotary-amplifier fields are controlled by the electronic power amplifiers.

Motor starting is accomplished at approximately 5.5 rpm by applying 200 amp at 12 v to the stator and 2 amp to the rotor. The motor synchronizes within 45 sec. Approximately 4 min are required to accelerate from minimum to maximum speed, and 2 min are required to brake from maximum speed to a standstill. Excessive acceleration and deceleration rates, which might cause the motor to drop out of synchronism, are prevented by an electromechanical brake, controlled by the rate of change of armature reaction of the motor. The brake prevents further change of oscillator frequency until the motor is stabilized.



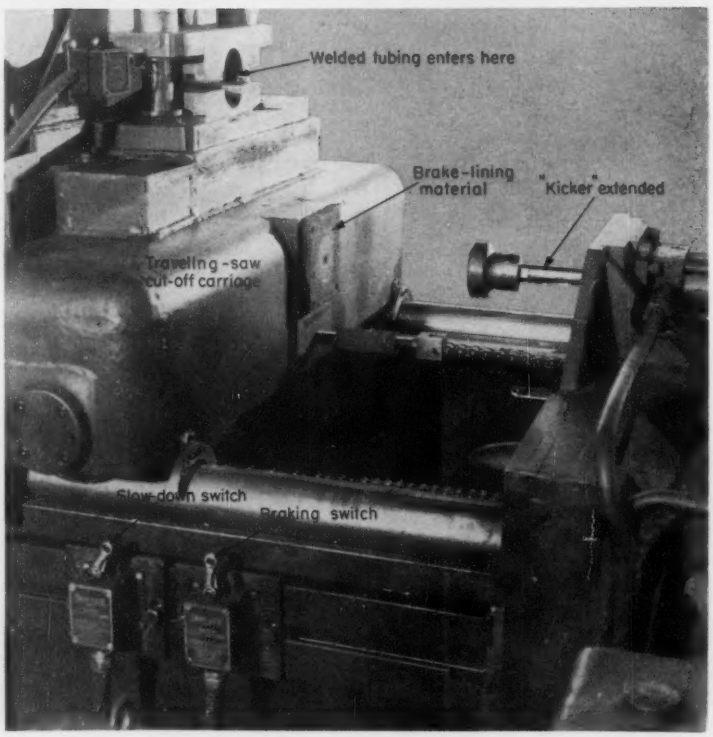
Rotary Power Amplifiers and Motor Controls

Hydraulic Kicker Accelerates Heavy Mass



HIGH-SPEED ACCELERATION of a heavy, traveling-saw cut-off carriage is achieved with a hydraulic ram member. Applied in a continuous, welded-tube mill designed by Abbey Etna Machine Co., the ram is operated by a hydraulic cylinder under 200 to 400 psi.

In operation, the carriage is pulled back to the kicking position by a roller-chain drive at a speed of 140 fpm. The roller chain is driven through a motor-powered, electrically operated friction clutch. As the carriage approaches the kicker end of the machine, it actuates a slow-down limit switch which disengages the electric clutch from the motor. The carriage slows down and strikes a braking limit switch which brakes the clutch. At this point the hydraulic ram is actuated, and it literally kicks the 3000-lb cut-off carriage in the opposite direction, accelerating it to the speed of the tubing—120 fpm.



A Practical Design Approach to

Oscillating-Load Bearings

By DONALD J. MYATT
Associate Professor of Engineering
Antioch College
Yellow Springs, Ohio

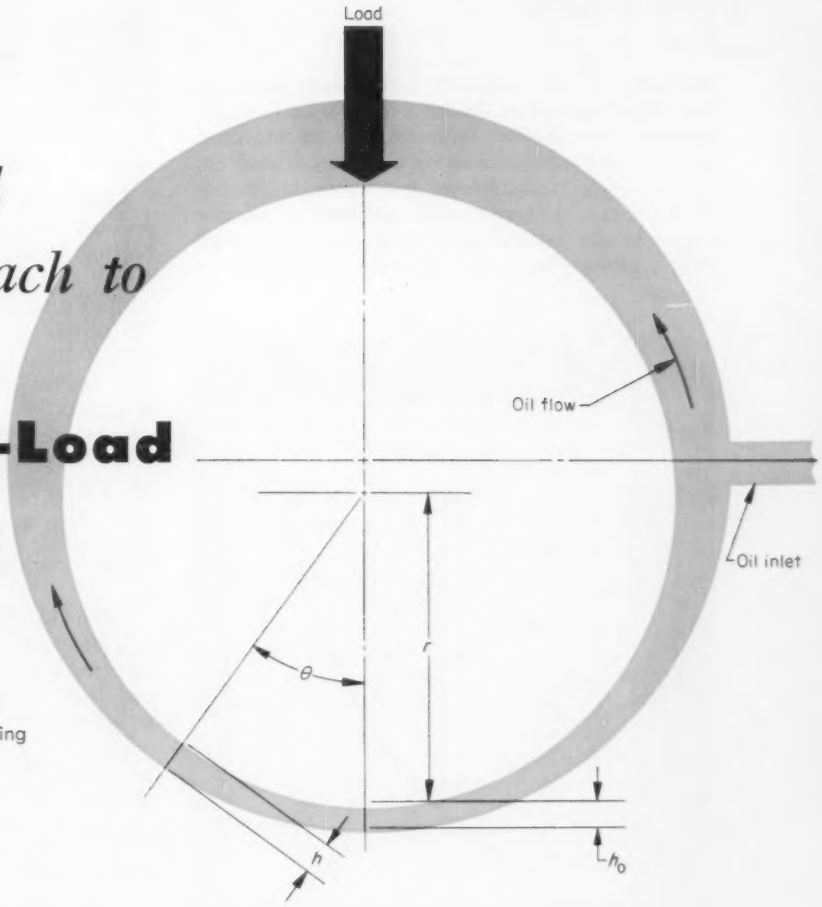


Fig. 1—Above—Journal and bearing action under an oscillating load

ACTION of an oscillating-load bearing, such as the wrist-pin bearing in an internal-combustion engine, differs in several ways from the action of bearings for which thick-film lubrication theory applies:

1. In the wrist-pin bearing, magnitude of the load varies widely during each revolution of the engine. Most bearings designed using thick-film theory carry relatively steady loads.

2. Load upon a wrist-pin bearing varies in direction, reversing for each revolution of the engine.

3. The wrist-pin journal oscillates in its bearing, never completing a full revolution; a bearing designed using thick-film theory depends upon revolution of the journal in the bearing to produce a load-supporting film of lubricant.

For these reasons, particularly the last, methods derived from hydrodynamic bearing theory (thick-film theory) are not applicable to design of bearings supporting oscillating-journal loads.

A journal and bearing being forced together under action of a load, W, are shown in Fig. 1. Assuming that the clearance space between journal and bearing is filled with oil and that bearing length is long enough in comparison to its diameter for oil flow along the axis to be negligible, oil will flow in a circumferential direction around the journal away from the high-pressure region. The oil-film

Nomenclature

c = Radial clearance, in.
h = Oil-film thickness at any given point, in.
h_0 = Minimum oil-film thickness, in.
K = Bearing squeeze-film coefficient
l = Axial bearing length, in.
N = Speed, rpm
P = Load per unit of projected bearing area $= W/2rl$, psi
r = Journal radius, in.
Δt = Time for oil film to escape from pressure area, sec
W = Load, lb
ε = Journal eccentricity
θ = Angle between point of h_0 to arbitrary point h
μ = Viscosity, reyns

thickness, h, will vary both with angular position, and with displacement of the journal relative to the bearing. The oil-film thickness can be expressed in terms of the radial bearing clearance, c, and the eccentricity, ε, of the journal relative to the bearing by $h = c(1 - \varepsilon \cos \theta)$. The quantity of oil displaced by the journal as it approaches the bearing with a given velocity and the load supported by a differential slot of oil can be used to determine amount of time required for the journal center to move from initial eccentricity, ε_1, to final eccentricity, ε_2:[1]

$$\Delta t = K \frac{24 \mu l r^3}{W c^2} \quad (1)$$

Solution to Equation 1 assumes that the oil-film pressure varies around the clearance space in the bearing from a maximum at h_0 to zero at a point ninety degrees away. In the actual bearing, positive oil-film pressure is probably maintained all around the periphery of the journal, but since the magnitude is difficult to specify at any point, the assumption assures conservative results when Equation 1 is applied.

Computed values of K, in terms of the journal eccentricity, are tabulated and plotted in Fig. 2. Since eccentricity is defined by $\varepsilon = 1 - rh_0/c$, a value of $\varepsilon = 1$ means the journal is in contact with the bearing; a value of $\varepsilon = 0$ means the journal is concentric with the bearing.

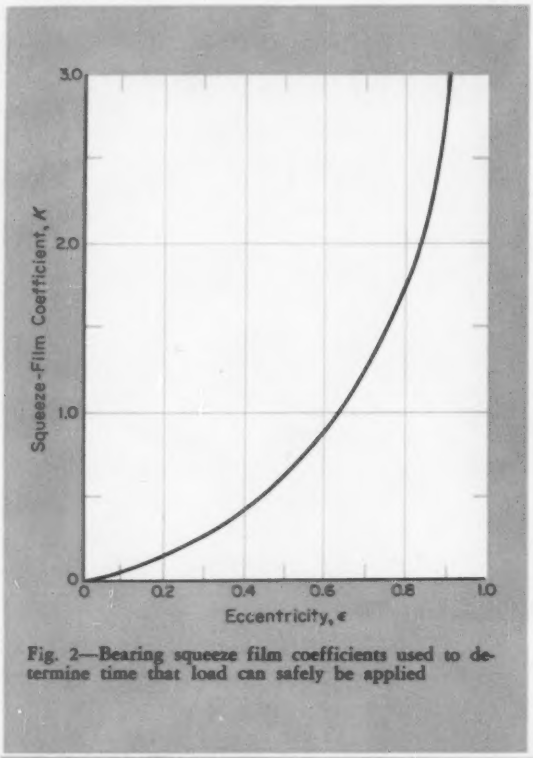


Fig. 2—Bearing squeeze film coefficients used to determine time that load can safely be applied

Oscillating-Bearing Design: Equation 1 can be used to estimate the time required for the oil film to be squeezed out of the clearance space between journal and bearing under load. Factors used in the computation include oil viscosity; bearing dimensions—length, radius, and clearance; bearing load; and minimum oil-film thickness. Knowing these factors, the time that the load can be applied safely can be calculated. This time is then compared with the time that the load is applied, usually a function of the speed of the machine.

If the time during which the load can be applied exceeds the duration of applied load, the design is considered safe. However, if the time calculated by Equation 1 is less than the period during which

[1]References are tabulated at end of article.

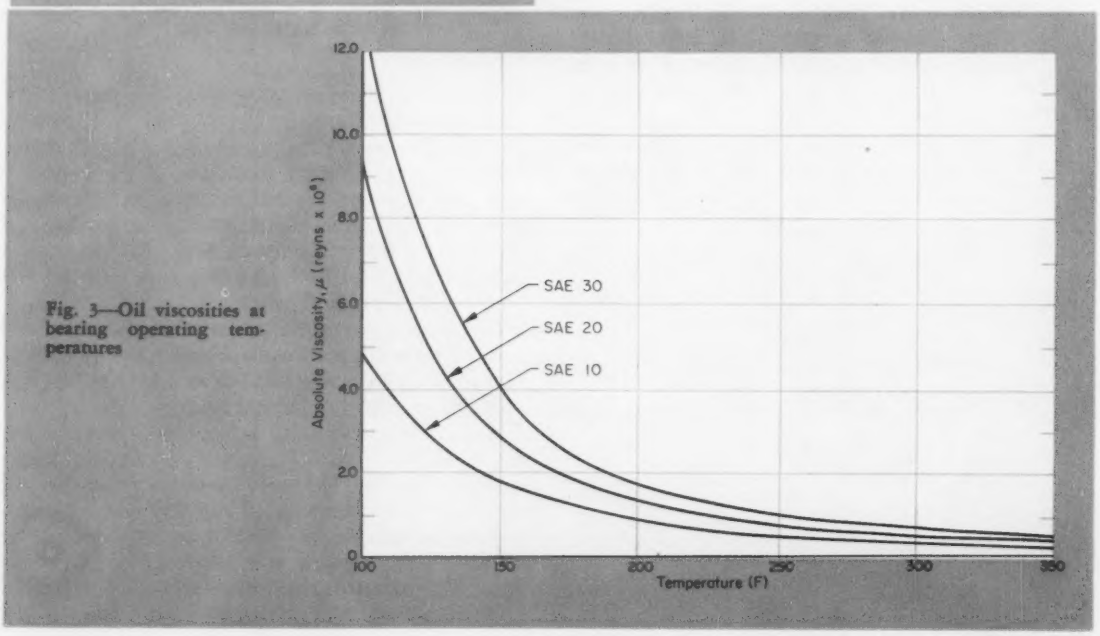


Fig. 3—Oil viscosities at bearing operating temperatures

the load acts, then metal-to-metal contact within the bearing is likely to occur. To prevent this happening, one or more specifications of the design should be changed. In this event, Equation 1 serves as a guide since it indicates effect produced by changes in bearing dimensions or the oil viscosity.

If the time interval during which a load acts is known or specified, Equation 1 may be solved directly for either the bearing dimensions or the oil viscosity. Because of the large number of variables involved, a number of them must be assumed or specified from other conditions involved in the design. Most of the conditions required for good oscillating-bearing design are similar to the conditions required of a well-designed rotating bearing.

Oil-Feed System: Safe loading time determined by Equation 1 depends upon keeping the clearance space between journal and bearing filled with lubricant. This equation assumes that axial oil flow is negligible in comparison to circumferential flow. In the actual bearing, some oil is usually lost out of the bearing ends. This oil must be replenished, so an oil-feed system should be included in the design. The oscillating bearing is similar to the rotating bearing in that the make-up oil should be fed into a low-pressure region. Since the load direction is reversed in many cases, the best location for the oil-feed inlet is usually ninety degrees away from the location of the major load.

Bearing-Design Limits: There is a vast amount of experience available from past designs.

BEARING SIZE: At present, there is a trend towards making the bearing length-to-diameter ratio small. For short bearings, the load-carrying capacity of the oil film is reduced by the effect of leakage from the ends of the bearing. However, short bearings reduce the problem of providing necessary stiffness in the journal so that shaft bending does not cause excessive local loads near the bearing ends. A guide for current practice can be obtained from the data gathered from several manufacturers' catalogs. For 1-in. diameter bearings, all with 1/16-in. wall thickness, length range varies from ½ to 2½ in.

BEARING-CLEARANCE MODULUS: For any particular application, there is a range of clearances that will provide best performance. This range depends on load-carrying capacity, minimum oil-film thickness, friction loss, manufacturing tolerances, etc. Minimum oil-film thickness, for instance, increases with an increase in clearance until it reaches a maximum; it then decreases if the clearance is increased additionally. General experience with all types of bearings indicates that the clearance modulus, c/r, should be between 0.0005 and 0.002.

OIL VISCOSITY: A choice of satisfactory oil viscosity would probably be covered by oils ranging from SAE 10 to 30. For a stationary engine or machine, oil-supply temperature can be maintained below a specified maximum temperature by an oil-cooling

Example of Bearing Calculations

Load diagram below is for a wrist-pin bearing for a 3⅜-in. bore and 5½-in. stroke internal-combustion engine operating at 2800 rpm. Integration of the area under the curve gives an average force of 780 lb acting during 270 deg of revolution. A 1-in. diam wrist-pin bearing, 1½ in. long is pressed into the connecting rod of this engine. Assuming that the pin is finished to 5 microinches rms and the bearing is finished to 32 microinches rms by a superfinish process, find a suitable radial clearance for this bearing.

Assume SAE 10, 20, or 30 oils operating at 180 F may be used; and use an oil-film safety factor of 2.

Duration of Load Acting: Time during which stroke occurs is 270/360 revolutions. . Thus, the duration is (270/360) (60/2800), or 0.0161 sec.

Minimum Oil-Film Thickness Allowed:

h_0 = Factor of safety × roughness peak factor × (pin roughness + bearing roughness)
= 2 × 7 × (5 + 32) mu in.
= 449 mu in.
h_0 = 0.000449 in.

Bearing Clearance:

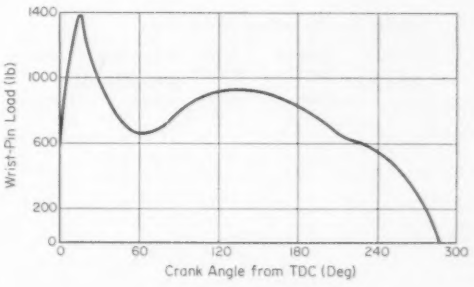
Assume c = 0.0003, 0.0006, and 0.0012; and solve for Δt for SAE 10, 20, and 30 oils.

Let c = 0.0003 in.

and $\epsilon = 1 - (r\,h_0/c)$
$= 1 - (0.5 \times 0.000449/0.0003)$
$\epsilon = 0.945$
K = 4 (from Fig. 2)

For SAE 10 oil at 180 F
$\mu = 1.08 \times 10^{-6}$ reyn (from Fig. 3)
$\Delta t = (24\,\mu\,l\,r^3/Wc^2)K$
$= (24 \times 1.08 \times 10^{-6} \times 1.5 \times 0.5^3/780 \times 0.0003^2)4$
Δt = 0.0139 sec for SAE 10
and Δt = 0.0224 sec for SAE 20
and Δt = 0.0280 sec for SAE 30

Table 4 summarizes results of similar calculations for the time interval during which the load can be applied to bearings similar in all respects to the above bearing except that the clearance has been changed.



Comparing these data with the duration of 0.0161 sec while the load acts indicates that the 0.0003-in. clearance is unsafe if SAE 10 oil is used and that the 0.0012-in. clearance is unsafe even for SAE 30 oil. Bearing clearance should range between 0.0004 and 0.0006 in. if all three grades of oil are to be used.

circuit. Range of maximum temperature rise for oil in most bearing installations is limited to 10 to 50 F, Fig. 3.

Minimum Oil-Film Thickness: The thinnest film of lubricant which will prevent contact between the bearing surfaces during operation is the minimum permissible oil-film thickness. Primarily, it depends upon roughness of the journal and bearing, rigidity of bearing construction, and size and kind of dirt particles that are likely to contaminate the oil. If bearing construction is rigid enough and if oil is kept filtered, surface finish of the bearing and journal control the minimum oil-film thickness.

Surface finish is the root-mean-square (rms) average height of the peaks and valleys of the surface. Ratio of peak-to-valley distance to surface finish value will vary from about four to ten in practice. Exact value depends more on the method of finishing than on the surface roughness. Some representative values[2] of peak-to-valley to root-mean-square surface finish are given in Table 1.

Bolz[3] has tabulated representative surface finishes which are commercially attainable for the different types of machine elements likely to have bearing contact. The values for journals and bearings are given in Table 2. In addition to an oil-film thickness equal to the sum of the peak-to-valley distances of the journal and bearing, a safety factor is sometimes applied to increase the film thickness. Magnitude of the safety factor depends upon the confidence of the designer in the data and analysis he is applying to the design.

Bearing Materials: Whether a bearing functions properly during its operation depends to a great extent upon the correct selection of bearing material. Requirements of the bearing material vary, depending upon the application; desirable properties of one of many available bearing materials must be matched to critical requirements of the application. This means that the engineer must determine the requirements of the bearing and properties of different bearing metals. The specific metal selected is one that possesses the optimum compromise of the required qualities. Typical ratings[4] of different bearing metals when tested under different bearing requirements are listed in Table 3. The designer should determine, for each individual case, the importance of the requirements. Listings in the table serve as a guide to evaluating capability of the bearing metals.

Manufacturing Tolerances: Economy in production is vitally connected with tolerances. Whether selective assembly or interchangeable manufacture is used as the basis for design will affect tolerances. In general, the tolerance should be as wide as possible to enable the part to function satisfactorily. The data[5] in Table 3 have been correlated with the surface-finish requirements given earlier.

Table 1—Production Surface Finishes

Finish Method	Ratio of Peak-to-Valley to Root-Mean-Square Roughness
Fine grind	5
Polish	7
Superfinish	7
Lap	10

Table 2—Bearing Surface Finishes

Type of Surface	Maximum Surface Roughness (microinch rms)
Piston pin	5
Crankpin	8
Connecting-rod bearing	20
Precision bearing	16
General practice	32

Table 3—Bearing Materials

Metal	Load-Carrying Capacity	Fatigue Strength	Anti-Seizure	Deformability and Embeddability	Cost
Lead-base babbitt	5*	3	1	1	2
Tin-base babbitt	5	3	1	1	3
Cadmium alloys	4	2	1	1	5
Copper-lead	3	2	2	2	6
Aluminum	2	2	2	3	4
Lead bronze	1	1	3	3	1
Thin overlay on copper-lead, aluminum, or silver	1	1	2	2	7

*Relative ratings: 1 is best.

Table 4—Safe Load Time

Oil	Clearance 0.0003 in.	Clearance 0.0006 in.	Clearance 0.0012 in.
SAE 10	0.0139 sec	0.0173 sec	0.0078 sec
SAE 20	0.0224	0.0280	0.0126
SAE 30	0.0280	0.0350	0.0157

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4. E. B. Etchells—"How Engineers Select Metals for Oil-Film Bearing Applications," *General Motors Engr. Journal*, Vol. 1, No. 5, 1954, p. 20. Abstracted in MACHINE DESIGN, July, 1954, p. 232.
5. R. W. Bolz—"Standard Fits and Tolerances," MACHINE DESIGN, Jan., 1955, p. 144.

They Say . . .

"A realization of the unsolved problems of the future should be a greater inspiration to our young men than the history of the problems which have been solved. Science and engineering have given this generation the key to a future full of far more promise than that of their forebears. It is up to us to see that these opportunities are seized and this depends upon our ability to tackle problems."—SIR GEORGE H. NELSON, *president, Institute of Electrical Engineers.*

Friction-Clutch Transmissions

Part 3—Thermal Capacities and Limitations

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Automotive Research Dept.
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Fig. 17 — Representative plates, steel at left and sintered bronze at right, removed from a damaged assembly, show random distribution of heat flux density and irregular distribution and size of spots which transmit heat to the bulk of the plates

It doesn't take long to burn out a clutch if its friction faces are not matched to the loads and events of the closing cycle. To prevent untimely thermal damage, designers must know what temperatures the friction materials can take, and what temperatures will likely be generated. Physical tests-to-destruction could give the answer—but expensively. At far less cost, this article provides the structure for analytical models that yield reliable values of essential thermal data.

EXPERIENCE shows that most premature clutch failures can be attributed to excessive surface temperatures generated during slippage under axial load. Even moderate loads and slow speeds produce high instantaneous temperatures. In physical tests, temperatures up to 1000 C in time intervals as short as 10^{-4} sec have been observed.

Consequences of excessive temperatures are serious. Metallic plates tend to weld together. On nonmetallic or semimetallic plates, friction materials disintegrate. Steel plates warp and develop surface cracks. Friction coefficients fluctuate appreciably, and oil oxidizes in lubricated clutches.

To prevent these failures at the design stage, two important values must be obtained:

1. Safe permissible maximum surface temperature.
2. Maximum surface temperature likely to occur under known conditions of loading.

Answers to both these questions are elusive. Perhaps the most accurate information can be obtained from exhaustive physical tests. But this procedure is expensive, and results are not always reliable for friction materials which are poor electrical conductors.

This article provides an analytical approach. A

basic limitation is that the reliability of results depends on the assumptions made before equations are set up and solved. At the outset, however, an important point is emphasized: Although calculated values of surface temperature may differ significantly from actual transient local values, the equations express the manner in which temperature varies with system parameters. Thus, the equations show which of the parameters should be changed to obtain a desired change in temperature.

Analytical Assumptions

Temperature of the clutch plates will be evaluated by solving the Fourier conduction equation. To do so, the assumptions which follow are necessary.

1. *Heat flux generated at the rubbing interface is uniformly distributed over the total frictional area of the clutch. That is, rate of energy dissipation is a function of time only.*

This appears to be quite a sweeping assumption. A challenging argument is: If the pressure due to the axial clamping force is uniformly distributed over the plate area, the rate of heat generation would be directly proportional to the tangential velocity and, therefore, to radial position on the plate.

Another challenging argument is the assumption that the rate of wear of the rubbing surfaces, and not the intensity of pressure, is uniformly distributed over the area of the plate. If rate of wear is proportional to both tangential velocity and pressure, it can be shown that the product of pressure and radius must be a constant, $pr = C$. If this reasoning is extended, it can be concluded that also the rate of heat generation is uniform over the whole plate

Each of these arguments may hold under certain conditions, but it is instructive to see what an actual clutch assembly reveals, Fig. 17. Here, a representative pair of clutch plates removed from a damaged assembly show how randomly distributed heat flux density really is, and how irregular is the number and size of spots through which heat enters the bulk of the plate. These observations discount both arguments.

How then is assumption 1 justified? First, in a properly designed system, the rate of heat dissipation is a function of time—it decreases from an initial maximum value at the beginning of the slip period to zero at the end.

Secondly, most clutches are so designed that the ratio of OD to ID of the plate is not much greater than unity (about 1.3). Therefore, the effect of the heat flux variation (directly with radius) on plate temperature is small.

Last, it must be remembered that the purpose of this article is not the exact calculation of plate surface temperature, but rather the development of a method leading to a more rational estimation of the thermal capacity of a clutch than is possible by consideration of the rate of energy dissipation alone.

2. *Heat transfer from the clutch plates to the surroundings during slipping is negligible. That is, no heat generated escapes to the outside during the slip period.*

This assumption is particularly justified when slip periods are of short duration—several seconds or less. Also, in most clutches the edge area of the plate is much smaller than the area receiving heat. Thus, heat flow in the radial direction is small and can be neglected in comparison with the flow in the axial direction.

3. *The effect of the lubricating oil is neglected.*

The effect of lubricant is difficult to trace because lubrication changes from hydrodynamic to boundary

Nomenclature

A, B = Constants; also plate plane designations
A_f = Total effective friction area, entire clutch, sq ft, also sq in.
a, b = Constants
C = $c\rho$
c = Specific heat, Btu per lb-deg F
F = Axial clamping force, lb
I = Moment of inertia, lb-ft-sec^2
k = Thermal conductivity, Btu per sq ft per hr per deg F per ft, also Btu per sq ft per sec per deg F per ft
l = One-half plate thickness, in., also ft
M = $(I_1 T_E + I_1 T_R)/(I_1 + I_2)$
P = $I_1 I_2/(I_1 + I_2)$
Q = Total energy dissipated during slip period, lb-ft
Q_S = Energy absorbed by steel plate, per unit area, Btu per sq ft
$q(t)$ = Rate of energy dissipation per unit area, Btu per sec per sq ft
$q_o(t)$ = Rate of energy dissipation during slip period, lb-ft per sec
R_1 = Thermal resistance, $1/k_1$
T = Clutch frictional torque, lb-ft
T_E = Engine output torque, lb-ft
T_R = Resistive load torque, lb-ft
t = Time, sec
t_m = Time when max plate surface temp occurs, sec
t_o = Slip period, sec
x = Distance from a point in a plate to the plate surface, in.
α = Equation constant, Btu per sec^2 per sq ft, see Equations 79 and 80
β = Equation constant, Btu per sec per sq ft, see Equations 79 and 80
ζ = $\beta_1 \sqrt{\frac{R_1}{C_1}}$
θ = Plate temperature, deg F
μ = $k_1/(k_1 + k_2)$
ξ = $\alpha_1 \sqrt{\frac{R_1}{C_1}}$
ρ = Density, lb/cu ft
Ω = Angular velocity, particular, rad per sec
$\omega(t)$ = Angular velocity, general, rad per sec

Subscripts 1 and 2 pertain to engine and load sides, respectively, of a power transmission system; also, central steel separator plate and adjacent friction plates, respectively, in a clutch.

Conversion Factors:

lb-ft $\times$ δ = (lb-ft)(1.285×10^{-3}) = Btu
lb-ft/sec $\times$ $(1.071 \times 10^{-4})/A_f$ = Btu per sec per sq ft

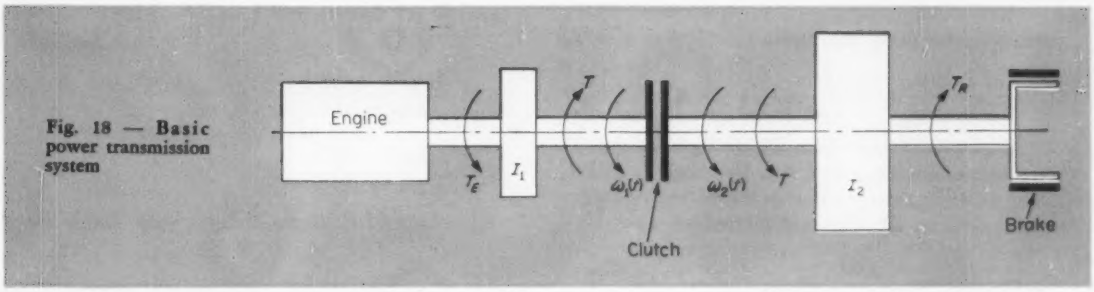


Fig. 18 — Basic power transmission system

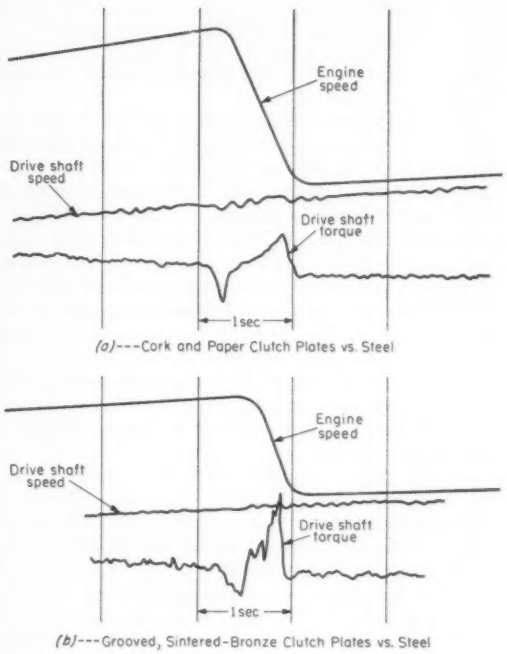


Fig. 19 — Representative oscillograms show variation of engine speed, drive shaft speed, and drive-shaft torque vs. time, during automatic shift in an automobile transmission

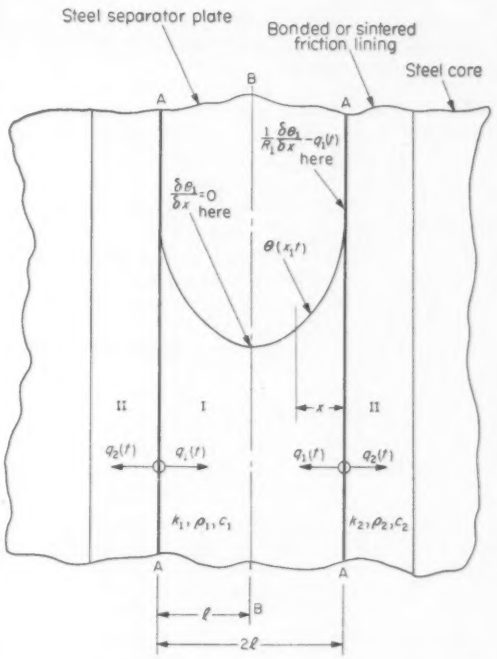


Fig. 20—Intensity and flow of heat generated at the rubbing surfaces of a friction clutch

type while the oil is squeezed out of the space between the plates as they close. Generally, the presence of oil lowers surface temperature considerably. Depending on the type of lubricant, under boundary lubrication conditions, temperature can be 30 to 60 per cent lower than in the case of dry friction.

▶ Rate of Energy Dissipation

The first objective is the form of the expression for the rate of heat dissipation. For this purpose, consider a basic power transmission system, Fig. 18. There, the resistive load torque, T_R, is simulated by the brake. For simplicity, all torques are assumed constant.

When compliance of the system is neglected, it is shown that

$$\omega_1(t) = \frac{T_E - T}{I_1}\, t + \Omega_1 \tag{64}$$

$$\omega_2(t) = \frac{T - T_R}{I_2}\, t + \Omega_2 \tag{65}$$

where Ω_1 and Ω_2 are initial velocities of the two shafts.

The rate at which energy is dissipated in the clutch during slipping is given by

$$q_o(t) = T[\omega_1(t) - \omega_2(t)] \tag{66}$$

$$q_o(t) = T\left[\frac{(I_2 T_E + I_1 T_R) - T(I_1 + I_2)}{I_1 I_2}\, t\right] + T(\Omega_1 - \Omega_2) \tag{67}$$

The duration of the slip period is given by

$$t_o = \frac{I_1 I_2(\Omega_1 - \Omega_2)}{T(I_1 + I_2) - (I_2 T_E + I_1 T_R)} \tag{68}$$

The total amount of energy dissipated during slipping (in one cycle) is obtained by integrating

Equation 67 between the limits $t = 0$ and $t = t_o$.

$$Q = \frac{T(\Omega_1 - \Omega_2)^2 I_1 I_2}{2T(I_1 + I_2) - (I_2 T_E + I_1 T_R)} \tag{69}$$

A special case occurs when $T_R = T_E = 0$, that is, when the system consists of two flywheels I_1 and I_2 rotating at different speeds with no external torques. Then, Equations 67, 68, and 69 reduce to

$$q_o(t) = T\left[\Omega_1 - \Omega_2 - T\left(\frac{I_1 + I_2}{I_1 I_2}\right)t\right] \tag{70}$$

$$t_o = \frac{I_1 I_2(\Omega_1 - \Omega_2)}{T(I_1 + I_2)} \tag{71}$$

$$Q = \frac{I_1 I_2(\Omega_1 - \Omega_2)^2}{2(I_1 + I_2)} \tag{72}$$

Equations 67 through 72 have very simple math-

Example 1

Consider a system in which the clutch is the multiple disc type with alternate steel and cork-coated plates. System and clutch data are

$I_1 = 1.25$ lb-ft-sec^2
$I_2 = 3.75$ lb-ft-sec^2
$\Omega_1 = 500$ rad/sec
$\Omega_2 = 200$ rad/sec
$A_f = 70$ sq in. $= 0.487$ sq ft
$2l = 0.080$ in.; $l = 0.040$ in. $= 3.33 \times 10^{-3}$ ft
k_1 (steel) $= 24$ Btu/sq ft-hr-deg F/ft
$= 6.67 \times 10^{-3}$ Btu/sq ft-sec-deg F/ft
k_2 (cork) $= 0.024$ Btu/sq ft-hr-deg F/ft
$c_1 = 0.14$ Btu/lb-deg F
$\rho = 489$ lb/cu ft

Then, from equations developed in this article,

$$t_o = \frac{281}{T} \text{ sec}$$

$$Q = 42.1 \times 10^3 \text{ lb-ft}$$

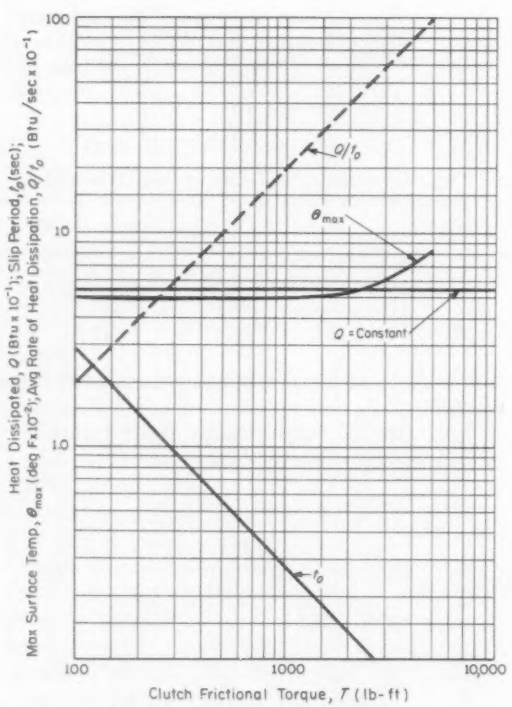


Fig. 21—Thermal properties and capabilities of a multiple-disc clutch system vs. clutch frictional torque

$$Q_s = 111.0 \text{ Btu/sq ft}$$

$$\theta_{1\,max} = 486 + (1.242 \times 10^{-5})T^2 \text{ deg F}$$

Also, average rate of heat dissipation during the slip period is $q_o(\text{avg}) = Q/t_o$.

These results are plotted vs. T in Fig. 21. In this example, the graph shows that clutch frictional torque up to about $T = 10^3$ lb-ft has little effect on maximum surface temperature. Also, surface temperature in excess of 500 F would probably damage the cork friction lining unless the clutch is of lubricated or "wet" type. The presence of oil would reduce this value of temperature about 30 per cent. If the clutch is intended to perform under heavy duty conditions, surface temperature values of the order of 350 F would be considered too high. To obtain satisfactory performance, the total frictional area of the clutch would have to be increased. This is one reason why, for heavy duty applications, cork is not a suitable friction material if the size of the clutch package is to be kept small.

Another much more frequently used system is one (e.g. the automatic transmission in a motor vehicle) in which external driving and resistive torques, as well as the clutch frictional torques, act on the rotating inertias. In such systems, Equations 67, 68, and 69 are used to calculate the rate of energy dissipation, duration of slip period, and the total amount of energy dissipated per cycle. In the present case, observe that Q is no longer independent of T and that both t_o and Q approach infinity when $T = (I_2 T_E + I_1 T_R)/(I_1 + I_2)$.

Again, examine the effect of varying clutch frictional torque on maximum surface temperature when the change in T is brought about only by changing axial force on the clutch plates.

New expressions for ξ and ξ are derived and substituted in Equation 86 to obtain

$$\theta_{1\,max} = \frac{\delta \mu T(\Omega_1 - \Omega_2)^2 P}{2A_f l(T - M)C_1} + \frac{7\mu\delta T(T - M)l^3 R_1^2 C_1}{90 P A_f} \tag{89}$$

According to Equation 89, for a system as shown in Fig. 18 which has both driving and resistive torques, maximum surface temperature reaches very high values when the frictional clutch torque approaches the value of the engine output torque. The same equation also shows that when $T > (I_2 T_E + I_1 T_R)/(I_1 + I_2)$ (i.e., when t_o is very small), the contribution of the second term to the value of $\theta_{1\,max}$ may become appreciable. Consequently, in spite of decreased slip period, the surface temperature of the clutch plates may begin to increase.

Example 2

Consider a system, Fig. 18, in which the values of I_1, I_2, Ω_1, and Ω_2, are the same as in Example 1, and $T_E = 250$ lb-ft; $T_R = 200$ lb-ft. Then,

$$t_o = \frac{281}{T - 237} \text{ sec}$$

$$Q = \frac{54.2}{T - 237} \text{ Btu}$$

$$\theta_{1\,max} = 487 \left(\frac{T}{T - 237} \right) + (1.247 \times 10^{-5}) T(T - 237) \text{ deg F}$$

$$q_o(\text{avg}) = \frac{Q}{t_o}$$

All four of these quantities are shown plotted in Fig. 22 vs. clutch frictional torque.

Analysis of this case shows why so much effort is spent in the development of a friction clutch and the associated hydraulic control system in an automatic passenger-car transmission. The aim is finally to produce an economical clutch assembly and, at the same time, to make the transition from one geared ratio to the other as smooth as possible. Relatively large values of t_o are required. A 10 per cent variation in the coefficient of friction of clutch friction material may be sufficient to upset a carefully calibrated system, resulting either in a "bumpy" shift or, with very frequent shifting, a burned clutch.

If, in the system of Example 2, it is desired to lower the value of the maximum surface temperature by redesigning the friction elements, two methods are generally available:

1. Increase the total clutch frictional area A_f by increasing the number of plates or their size.
2. Increase the thickness of the steel separator plate.

In applying the first of these methods, Equation 89 shows that the maximum surface temperature is inversely proportional to the total frictional area A_f. It follows that virtually any desired value of maximum surface temperature may be obtained by assigning a proper value to A_f. This process, although very direct and very effective, may not always be the most economical. Usually, the addition of one or more sets of plates will be more expensive than the increase in thickness of the steel separator plates in a clutch already designed.

The question that arises in connection with the use of the second method is its effectiveness. To illustrate the variation of surface temperature with plate thickness, consider the system of Example 2, in which $T = 700$ lb-ft and is held constant. Then, with $\xi = 823$ and $\xi = 1358$, Equation 86 is used to plot $\theta_{1\,max}$ as a function of l. The result is shown in Fig. 23, where a plate of thickness $2l$, heated on both sides, is considered. The graph shows that, for all practical purposes, any increase in plate thickness beyond $2l = 0.25$ in. results in an almost undetectable decrease in the surface temperature.

Fig. 23 also compares maximum surface temperature, calculated from Equation 83, for $2l \to \infty$ and finite $2l$.

In order to establish a more general criterion for the maximum useful plate thickness, when heated on both sides, the nondimensional Fourier Number $F = t_o/l^2CR$ has been also plotted in Fig. 23 as a function of plate thickness. The graph shows that any increase in $2l$ beyond the value corresponding to $1/F = 1.75$ (approx), ceases to be significant. The result is

$$l_{max} = \sqrt{\frac{1.75\,t_o}{CR}} = \sqrt{\frac{1.75\,t_o\,k}{c\rho}} \qquad (90)$$

where $l_{max} = \frac{1}{2}$ maximum useful plate thickness when heated on both sides.

When the plate is heated on one side only, Equation 90 gives the actual maximum useful plate thickness.

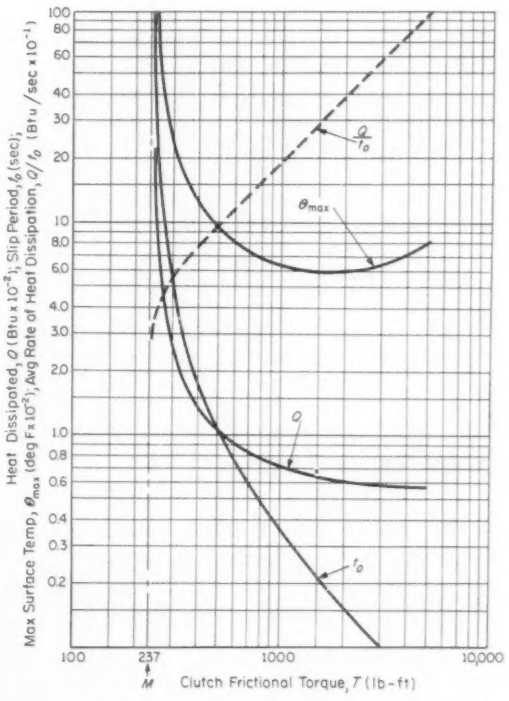


Fig. 22—Thermal properties and capabilities of a multiple-disc clutch system, including the influence of engine output torque and resistive load torque, vs. clutch frictional torque

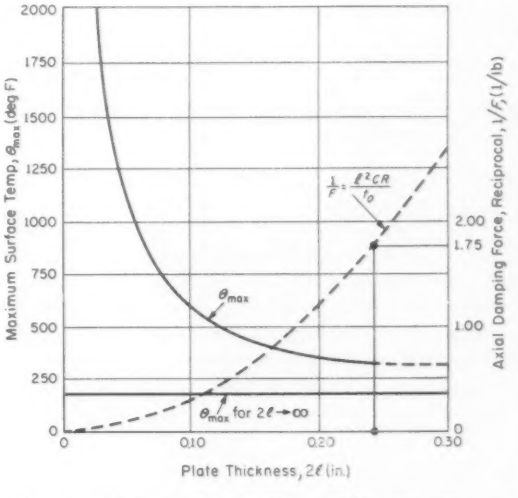


Fig. 23—Variation of maximum surface temperature, θ_{max}, with plate thickness. Plate is heated on both sides; $T = 700$ lb-ft; $t_o = 0.607$ sec

ematical form and thus could be used advantageously in further analysis provided they do not cause too great a departure from reality. To compare analysis with fact, examine Fig. 19. It shows oscillographic recordings of engine and driveshaft speeds in a passenger motor vehicle equipped with an automatic transmission and a hydrokinetic torque converter. Both oscillograms were taken during the shift from "low" to "high" gear. The change in the engine speed is a consequence of the application of a friction clutch of multiple-disc design.

Examination of Fig. 19*a* and 19*b* shows that in both cases the manner in which engine speed varies can be approximated by a straight line. This suggests that also the rate of heat dissipation varies linearly with time, and thus has the general form

$$q_o(t) = -At + B \tag{73}$$

which is identical to Equations 67 and 70.

To obtain the rate of heat dissipation per unit area in units of Btu per sec per sq ft, Equation 73 is multiplied by $1.071 \times 10^{-4}/A_f$. The resulting equation form is

$$q(t) = -at + b \tag{74}$$

Plate Boundary Conditions: Fig. 20 shows two clutch plates in contact under the action of an axial clamping force F. One plate is made of steel and the other is coated with friction material. Surfaces AA, where rubbing occurs, can be thought of as plane sources of heat, producing $q(t)$ Btu per sec per sq ft. At the rubbing interface the surface temperature of both plates I and II is the same. The rates of heat flow into I and II are not equal but depend on the thermal properties of the two materials in contact. Let these rates of heat flow into I and II be denoted by $q_1(t)$ and $q_2(t)$, respectively. Then, at the interface AA,

$$q(t) = q_1(t) + q_2(t) \tag{75}$$

and

$$\theta_1(x, t) = \theta_2(x, t) \tag{76}$$

where $\theta_1(x,t)$ and $\theta_2(x,t)$ are the temperatures of plates I and II, respectively. Also, at AA,

$$q_1(t) = k_1 \, \partial \, \theta_1/\partial \, x \tag{77}$$

$$q_2(t) = k_2 \, \partial \, \theta_2/\partial \, x \tag{78}$$

where k_1 and k_2 are thermal conductivities of the two materials in contact.

Usually, $\partial\theta_1/\partial x$ does not equal $\partial\theta_2/\partial x$, but if Equation 76 is to be satisfied, $\partial\theta_1/\partial t = \partial\theta_2/\partial t$ at surfaces AA, and it follows that

$$k_1 \frac{\partial \theta_1}{\partial x} - q_1(t) = \frac{k_1}{k_1 + k_2} q(t) = -\alpha_1 t + \beta_1 \tag{79}$$

$$k_2 \frac{\partial \theta_2}{\partial x} = q_2(t) = \frac{k_2}{k_1 + k_2} q(t) = -\alpha_2 t + \beta_2 \tag{80}$$

In units of Btu per sec per sq ft, Equations 79 and 80 are the boundary conditions at $x = 0$.

At the mid-plane BB in Fig. 20, the temperature gradient must be zero because plate I is heated uniformly on both sides. That is, at $x = l$, $\partial\theta_1/\partial x = \partial\theta_2/\partial x = 0$. This equation and Equation 79 are boundary conditions necessary for the solution of Equation 81.

Plate Temperature: With these assumptions, the Fourier conduction equation assumes the form

$$\frac{\partial^2 \theta_1}{\partial x^2} = C_1 R_1 \frac{\partial \theta_1}{\partial t} \tag{81}$$

where $C_1 = c_1\rho_1$ and $R_1 = 1/k_1$. The terms k_1, c_1, and ρ_1 are thermal conductivity, specific heat, and density, respectively, of steel.

To obtain surface temperature as a function of time, it can be shown that

$$\theta_1(o, t) = \zeta \left[\frac{t}{l_1\sqrt{R_1 C_1}} + \frac{l\sqrt{R_1 C_1}}{3} - \frac{2l\sqrt{R_1 C_1}}{\pi^2} \sum_{n=1}^{\infty} \frac{1}{n^2} e^{Gt} \right] - \xi \left[\frac{t^2}{2l\sqrt{R_1 C_1}} + \frac{l\sqrt{R_1 C_1}\, t}{3} - \frac{l^3 (C_1 R_1)^{3/2}}{45} + \frac{2l^3 (C_1 R_1)^{3/2}}{\pi^4} \sum_{n=1}^{\infty} \frac{1}{n^4} e^{Gt} \right] \tag{82}$$

where

$$\zeta = \beta_1 \sqrt{\frac{R_1}{C_1}}, \; \xi = \alpha_1 \sqrt{\frac{R_1}{C_1}}, \text{ and } G = -\frac{n^2 \pi^2}{l^2 R_1 C_1}$$

Thick-Plate Expressions: Examination of Equation 82 shows that for very large values of $l\sqrt{RC}$, that is, for $l \to \infty$, $\theta_1(0,t)$ assumes indeterminate form. In most clutch assemblies, space and weight limitations dictate small values of l. However, for the purposes of this article, it is important to examine the form of $\theta_1(o,t)$ for very large values of l. For $l \to \infty$, the expression is

$$\theta(o, t) = 2\zeta \sqrt{\frac{t}{\pi}} - \frac{4}{3} \left(\frac{\xi t^{3/2}}{\pi} \right) \tag{83}$$

For $l \to \infty$, it can be shown that maximum temperature occurs at the time $t_m = t_o/2$ and that its value is $\sqrt{2}$ times that at $t = t_o$.

Application of Results

Few factors that influence results have been neglected in the preceding derivations. However, certain combinations of conditions and certain observations can expedite calculations.

Temperature Values: It must be remembered that both Equations 82 and 83 have been derived with the condition that $\theta_1(x,t) = \theta_2(x,t) = 0$ at $t = 0$. Thus, in calculations for maximum temperature during the slip period, the ambient temperature of the plate at $t = 0$ must be added to values obtained from Equations 82 and 83.

Thermal Conductivities: An interesting observation is the effect of the thermal conductivities k_1 and k_2 of *both* clutch plate materials. It is found that surface temperature is roughly proportional to $1/(k_1 + k_2)$. Thus, a fairly large variation in surface temperature may be caused by varying the conductivity of only one clutch plate. Also, to keep the surface temperature as low as possible, materials having large thermal conductivity should be used. Of course, high values of k_1 and k_2 are not the only criteria for selection of plate materials. Other factors are considered in the next article in this series.

Thin-Plate Temperature Effect: In practice, many clutches, especially those of multiple-disc type, are so designed that the thickness of the plate, $2l$, rarely exceeds 0.10 in. When this value of l (0.05 in.) is substituted in Equation 82, the constant in the exponent of e becomes

$$G = \frac{n^2 \pi^2}{l^2 R_1 C_1} = 71.3\, n^2$$

Thus, even with $t = 0.1$ and $n = 1$, $e^{-7.13} \approx 9 \times 10^{-4}$. For all practical purposes, the contribution of infinite series in n could be neglected.

With this simplification, for small values of l, Equation 82 becomes

$$\theta_1(o, t) = -\frac{\xi t^2}{2l\sqrt{R_1 C_1}} + \left(\frac{\xi}{l\sqrt{R_1 C_1}} - \frac{\xi l\sqrt{R_1 C_1}}{3} \right) t + \frac{\xi l\sqrt{R_1 C_1}}{3} + \frac{\xi l^3 (R_1 C_1)^{3/2}}{45} \quad (84)$$

Maximum Surface Temperature: To find maximum surface temperature of the plates, Equation 84 is differentiated and $\partial\theta_1/\partial t$ is set equal to 0. Then, the time of incidence of the maximum surface temperature is

$$t_m = \frac{\xi}{\xi} - \frac{l^2 R_1 C_1}{3} = t_o - \frac{l^2 R_1 C_1}{3} \quad (85)$$

This expression indicates that t_m is dependent on the duration of the slip period, plate thickness, and thermal properties of plate material.

By substitution of the value of t_m from Equation 85 into Equation 84, the maximum surface temperature, for small values of l, is

$$\theta_{1\,max} = \frac{1}{2}\left(\frac{\xi^2}{\xi l\sqrt{R_1 C_1}} \right) + \frac{7}{90}\, \xi\, l^3 (R_1 C_1)^{3/2} \quad (86)$$

Useful observations are derived from Equation 86, depending on the nature of the system of which the clutch is a part. Thus, in a system which consists of two flywheels rotating at different speeds in the absence of external torques, and the purpose of the clutch is to transfer energy from one flywheel to the other (as in inertia starters), Equation 72 shows that the total amount of energy dissipated in the clutch during the process of coupling is independent of the clutch frictional torque T. On the other hand, the duration of the slip period t_o, in Equation 71, is inversely proportional to T.

The question may be raised: How does the change in t_o, caused by varying T, affect the maximum surface temperature of the plates? It is to be understood that the variation of clutch frictional torque is affected by adjusting only the axial clamping force F. Clutch dimensions, number of plates, and frictional and thermal properties of the plates are held constant.

This problem may arise when it is desired to adapt a clutch of certain thermal and mechanical capacity to a system demanding a higher capacity clutch. The deficiency can be compensated for by increased pressure on the frictional surfaces.

To express Equation 86 in other terms, it can be shown that the amount of energy absorbed by the steel plate per unit surface area is

$$Q_S = \mu\, \delta\, \frac{Q}{A_F} \quad (87)$$

where δ is the conversion factor from lb-ft to Btu.

This and other substitutions in Equation 86 yield

$$\theta_{1\,max} = \frac{Q_S}{lC_1} + \frac{7}{45}\left[\frac{Q_S\, T^2\, l^3\, R_1{}^2\, C_1 (I_1 + I_2)^2}{I_1{}^2\, I_2{}^2 (\Omega_1 - \Omega_2)^2} \right] \quad (88)$$

Although the contribution of the second term in Equation 88 to the value of θ_{1max} becomes appreciable only at very high values of T, it will be observed that surface temperature is proportional to the square of the clutch frictional torque. Thus, in the case when the clutch is used to start or stop pure inertia loads, too small—*not* too large—values of t_o will tend to damage the clutch.

The next article, last in this series, concludes the treatment of thermal factors in clutch operation. Summary conclusions show how best to compromise clutch operation, instantaneous flash temperatures, and bulk temperatures of a clutch assembly.

They Say . . .

"Personal achievement is not only a key to happiness, it is our only hope of national survival. For once the Russians out-achieve us significantly, we will live only by their grace and consent. And the Russians know, and we should know, that national achievement comes from hard work—not alone from a few top-drawer scientists, but from the sound and solid work of a whole people."—CHARLES H. BROWER, *president, Batten, Barton, Durstine and Osborn.*

"Fundamental research is the source from which applied research flows. The depletion of reserves in the less tangible area of basic knowledge produces a scarcity just as real as in the field of physical materials."—JOHN T. RETTALIATA, *president, Illinois Institute of Technology.*

marking electronic chassis

. . . *for easy assembly and maintenance*

By FRANK WILLIAM WOOD JR.
Design Engineer
Vitro Laboratories
Silver Spring, Md.

INADEQUATE or improper marking of electronic chassis and components can cause at least two major problems. First, malfunctioning equipment may be produced because electronic components are incorrectly mounted or wired. The cost of repairing such units can all but wipe out any possible profit margin.

Second, equipment in which parts are poorly marked may be difficult to maintain. This situation will do little to build customer confidence in future sales.

A number of design recommendations are given here for correct chassis marking and component identification. These are summarized in Table 1.

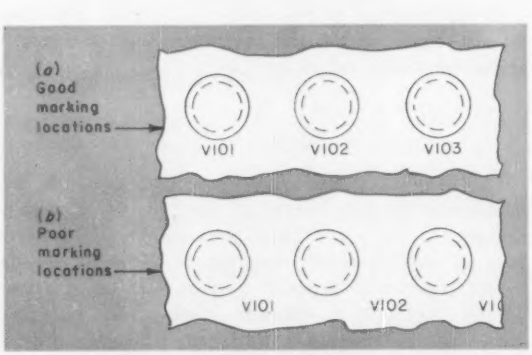
Marking location may be limited by the marking process selected. Therefore, one of the first considerations in marking electronic equipment should be the method of marking. Several possible processes are listed in Table 2 along with the characteristics of each. Remember that the application and expected life of the equipment determine how permanent the marking needs to be. Of course, any method chosen should be made as permanent as possible.

Table 1—Twelve Rules for Electronic-Chassis Marking

1. Locate markings adjacent to referenced component.
2. Make markings legible.
3. Decide how permanent markings should be.
4. Be sure markings are visible without moving any components.
5. Locate markings in relation to each component in a consistent manner.
6. Use correct designation letters.
7. Orient markings so they can be read when chassis is installed in console.
8. Be sure adequate information is provided on adjustable-control markings.
9. Mark stacked components so they can be individually recognized.
10. Clearly identify individual sections of dual electrical or electronic components.
11. Make sure markings will not be lost if components are removed.
12. Identify tubes or other components which are enclosed on the outside of the enclosure.

Table 2—Marking Methods

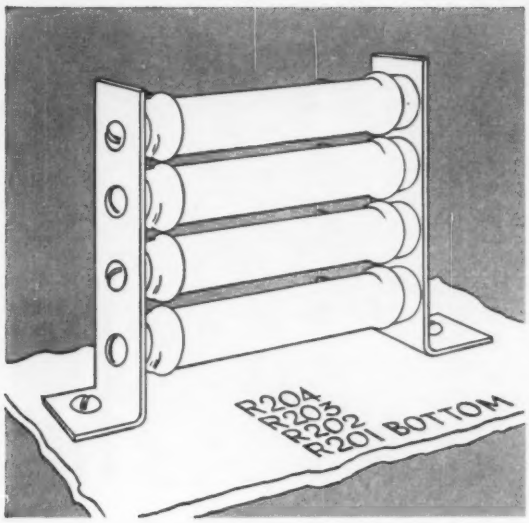
Method	Characteristics
1. Rubber stamp	a. Slow process. b. Suited only for very small quantity. c. Quality varies with application skill. d. Changes are easily made.
2. Engraving	a. High in cost. b. Suited only for small quantities. c. Changes cannot be made easily. d. Permanent.
3. Silk screen	a. Professional appearance. b. Suited for high quantity.
4. Simulated silk screen	a. Professional appearance. b. Suited for small to medium quantity, 5 to 500 pieces.
5. Decalcomania	a. Professional appearance. b. Slow process not suited for production. c. Not applicable to military equipment.



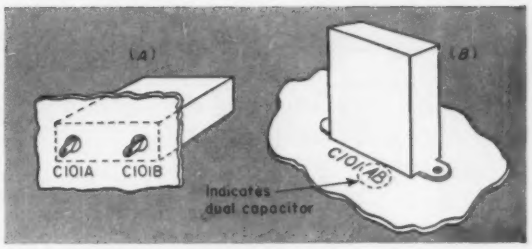
Identify markings specifically with each chassis component, **a.** Don't mark half way between two components, **b,** because positive identification is often impossible.

Military Publications on Chassis Marking

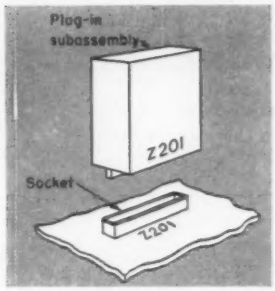
1. "Simulated Silk-Screen Labeling Process for Electronic Equipment," *Navy Electronics Laboratory Reliability Design Handbook*, Code 4350, Section 4.13, Page 1, 18 June, 1954.
2. *Military Specification: Ink, Marking, Quick-Drying (for Nonporous Surfaces)*, MIL-I-16557A, 18 February, 1952.
3. *Military Standard: Electrical and Electronic Reference Designations*, MIL-STD-16B, 1 June, 1956.
4. *Military Specification: Marking of Electronic Items*, MIL-M-13231 (Sig C), 25 January, 1954.
5. *MIL-E*-19100.
6. *MIL-E*-16400.



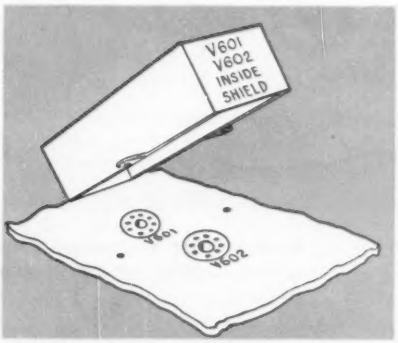
Key multiple markings for stacked components with an order-of-stacking starting point, such as "top" or "bottom."



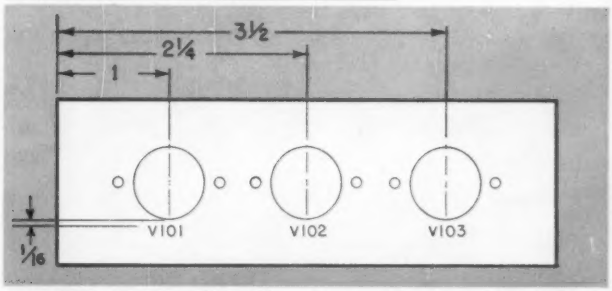
Mark sections of dual components on both the bottom, **a**, and top, **b**, of chassis



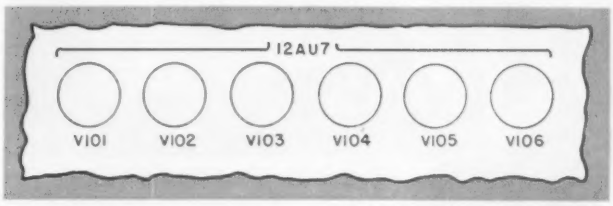
Place identical numbers on both the chassis and the removable part of a plug-in subassembly.



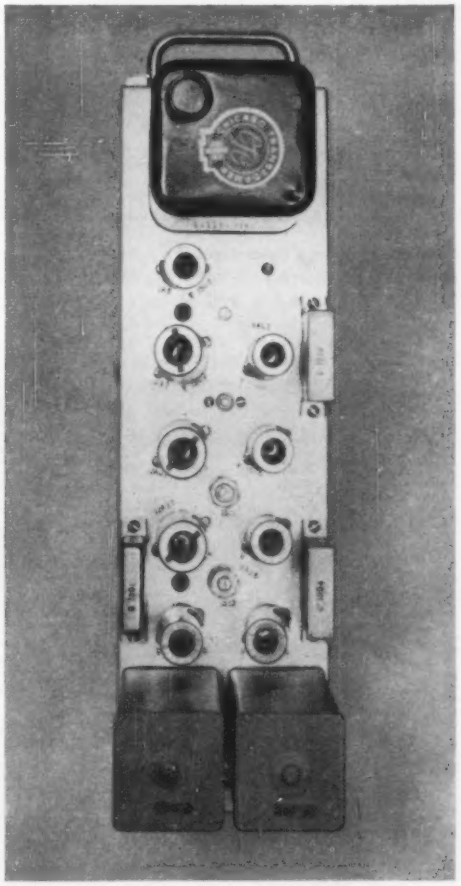
Label enclosed components on both the inside and outside of the shield.



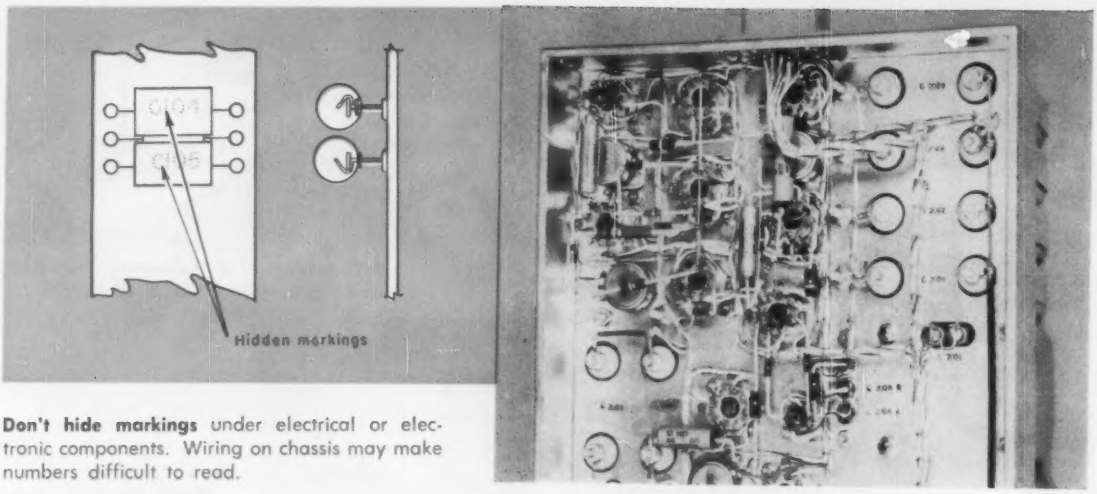
Show exact locations of markings with a dimensioned drawing of the chassis.



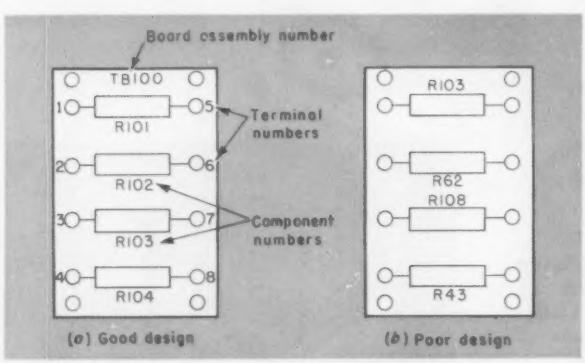
Mark identical tube types, lined up in a row, with one tube number placed between leaders. A unique number should also be placed under each tube socket to distinguish each tube in the schematic.



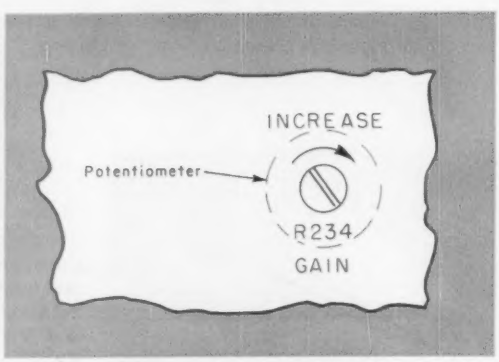
Avoid marking on replaceable components because the number may be lost unless chassis is also marked. Keep markings parallel to one edge of chassis unless space is limited.



Don't hide markings under electrical or electronic components. Wiring on chassis may make numbers difficult to read.



Position markings consistently. Leave no room for human judgment in determining component and part-number association. The markings in **a** are well placed. Those in **b** are ambiguous.



Mark increase or decrease indications clearly on adjustable controls.

Photo, courtesy Grant Pulley and Hardware Co.

Orient markings right side up on side-mounted chassis. Always determine final mounting position of a chassis before labeling chassis.

CHARTS FOR BEAM DESIGN

Deflection? Natural frequency? Stiffness coefficients, charted here, provide quick and easy answers to such problems. They apply to uniform-section, small-deflection members.

By JEROME E. RUZICKA
Staff Engineer
Barry Controls Inc.
Watertown, Mass.

SINCE beams display elastic properties, deflection under load is dependent upon the beam rigidity. The "stiffness coefficient" is a convenient tool for analyzing beam members. It is made up of two parameters: The reference stiffness, and the position along the beam at which the stiffness is desired. Although the analysis is simple, resulting expressions and charts are useful in many structural design and linear vibration problems.[1]

Analysis: For small beam deflections, the load-deflection characteristics are determined by elementary theory.[2] Throughout this analysis, the sign conventions for displacements, shear forces, and bending moments are those commonly used in the literature.

The equation which relates the bending moment to beam curvature for small deflections is (see Nomenclature)

$$M = -EI\frac{d^2w}{dx^2}$$

and the equation for shear in terms of beam deflection is

$$S = -EI\frac{d^3w}{dx^3}$$

The beams discussed in this article have constant flexural rigidity, EI, and no transverse load function. Fig. 1 shows a schematic diagram of a uniform beam with no transverse load function, and the general solution for deflection of that portion of

[1]References are tabulated at end of article.

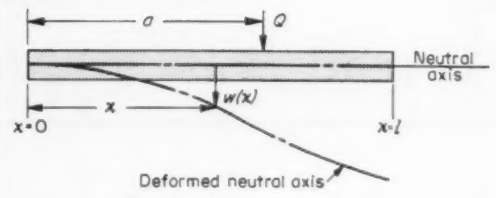


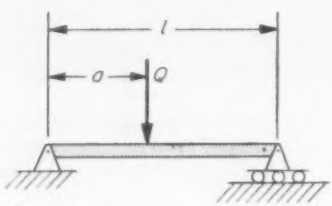
Fig. 1—Schematic diagram of beam configuration

Nomenclature

a = Position on beam at which stiffness is required, in.
E = Modulus of elasticity, psi
f = Frequency, cps
g = Acceleration due to gravity, in. per sec^2
I = Moment of inertia of cross-sectional area about neutral axis, in.^{4}
K_a = Stiffness coefficient at point $x = a$ on beam, lb per in.
K_r = EI/l^3 = Reference stiffness coefficient, lb per in.
l = Length of beam, in.
M = Bending moment, in.-lb
Q = Concentrated load, lb
S = Shear force, lb
w = Transverse displacement of neutral axis, in.
x = Co-ordinate position
δ_{st} = Static deflection, in.

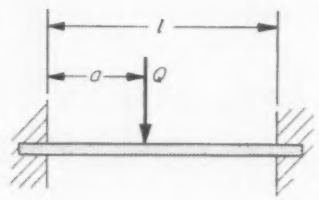
Fig. 2—Beam stiffness coefficients

Case 1: Hinge-Hinge



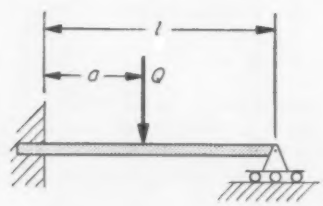
$$\frac{K_a}{K_r} = \frac{3}{\left(\frac{a}{l}\right)^2\left(1-\frac{a}{l}\right)^2}$$

Case 2: Clamp-Clamp

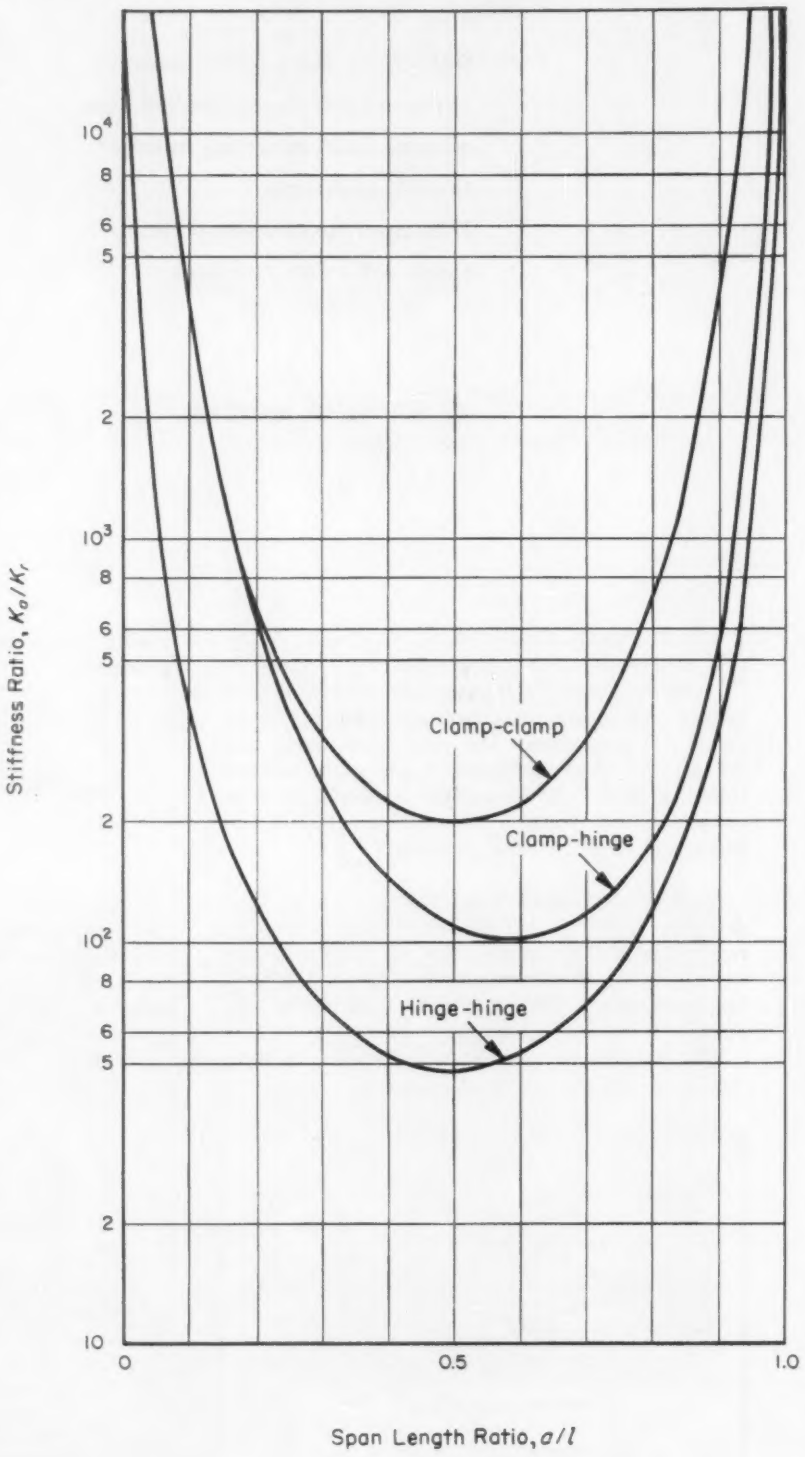


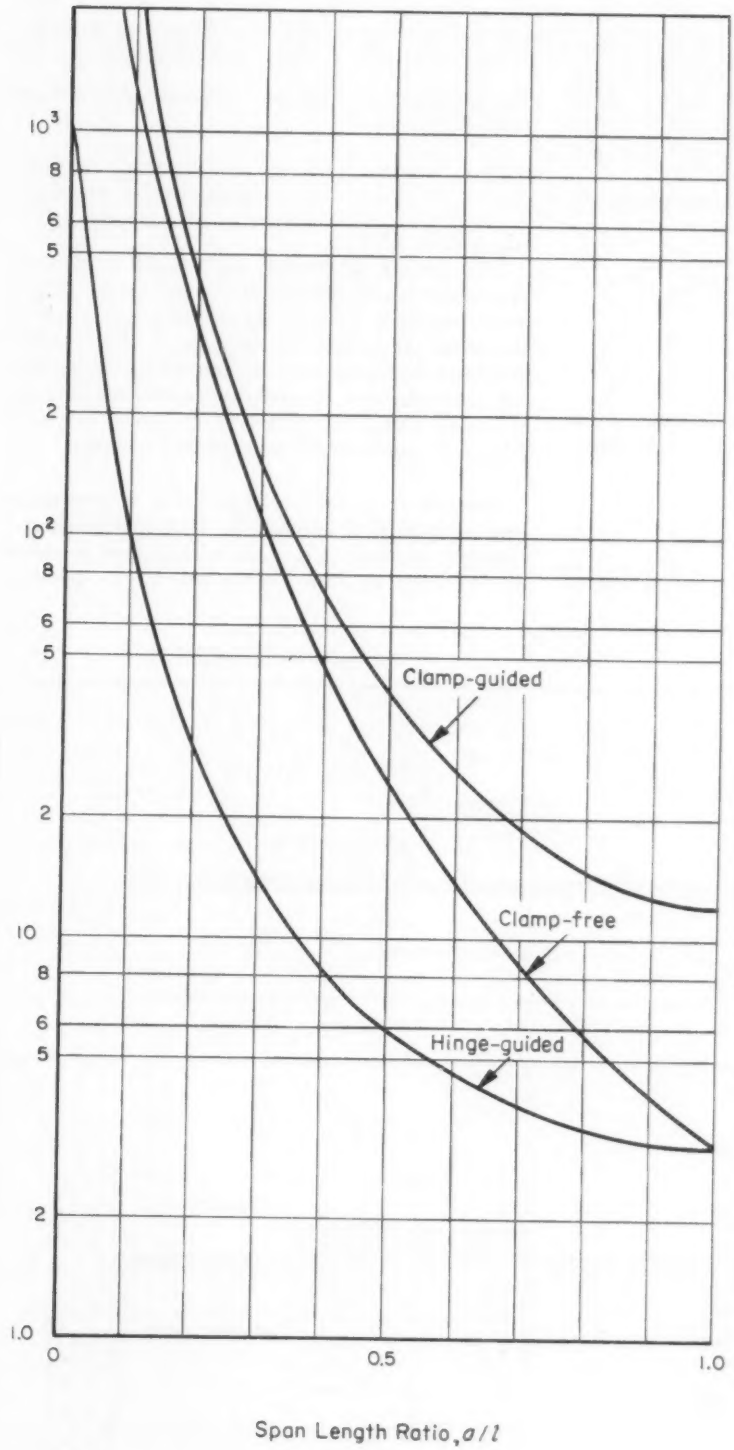
$$\frac{K_a}{K_r} = \frac{3}{\left(\frac{a}{l}\right)^3\left(1-\frac{a}{l}\right)^3}$$

Case 3: Clamp-Hinge

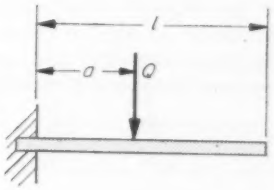


$$\frac{K_a}{K_r} = \frac{12}{\left(\frac{a}{l}\right)^3\left(1-\frac{a}{l}\right)^2\left(4-\frac{a}{l}\right)}$$



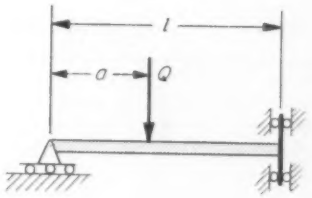


Case 4: Clamp-Free



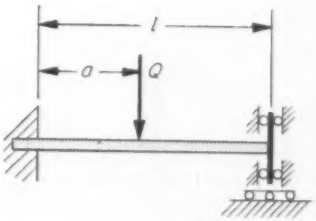
$$\frac{K_a}{K_r} = \frac{3}{\left(\frac{a}{l}\right)^3}$$

Case 5: Hinge-Guided



$$\frac{K_a}{K_r} = \frac{3}{\left(\frac{a}{l}\right)^2\left(3-2\,\frac{a}{l}\right)}$$

Case 6: Clamp-Guided



$$\frac{K_a}{K_r} = \frac{12}{\left(\frac{a}{l}\right)^3\left(4-3\,\frac{a}{l}\right)}$$

the beam bounded by end constraint and with a concentrated load is

$$w(x) = \frac{1}{EI}(Ax^3 + Bx^2 + Cx + D)$$

For the beams being considered, two such equations must be written: One for each of the intervals $0 < x < a$ and $a < x < 1$. Thus, in general, eight constants of integration must be evaluated to determine the over-all deflection characteristics of the beam due to the applied concentrated load.

The proper boundary and continuity conditions for the types of beams being considered are:

1. Hinged-boundary condition: $w = 0$ and $M = 0$
2. Clamped-boundary condition: $w = 0$ and $dw/dx = 0$
3. Free-boundary condition: $M = 0$ and $S = 0$
4. Guided-boundary condition: $dw/dx = 0$ and $S = 0$
5. Concentrated-load continuity conditions: $w_1 = w_2$, $dw_1/dx = dw_2/dx$, $M_1 = M_2$ and $S_1 - S_2 = Q$

After evaluating the constants of integration for a beam with given constraints, the displacement equation is

$$w(x) = \frac{Ql^3}{EI} f(x)$$

where $f(x)$ is some function of the co-ordinate position x which has a different form depending on which interval is considered. If x is made to coincide with the point of application of load Q (that is, $x = a$) the stiffness coefficient of the beam at that point is

$$K_a = \frac{Q_a}{w(a)} = \frac{EI}{l^3 f(a)}$$

The general expression for a dimensionless stiffness ratio is

$$\frac{K_a}{K_r} = \frac{1}{f(a)}$$

where $K_r = EI/l^3$.

This method of analysis was applied to six cases of uniform beams. The results of the analyses, Fig. 2, are expressed in terms of the a/l ratio which defines the point at which the stiffness is desired. The graphical representations of these solutions facilitate the determination of stiffness coefficients. Of the six cases considered, Cases 2, 4, and 6 are most frequently encountered in engineering design.

Example 1: A uniform steel beam of rectangular section is securely clamped at both ends in a mechanical structure, Fig. 3. If a 50-lb load is placed on the beam as shown, what will be the resulting

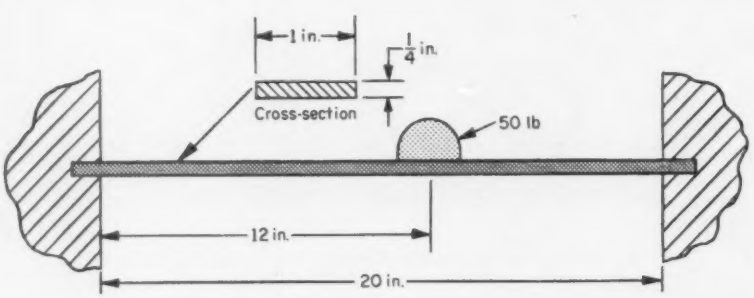


Fig. 3 — End-constrained beam with uniform cross-section and concentrated load

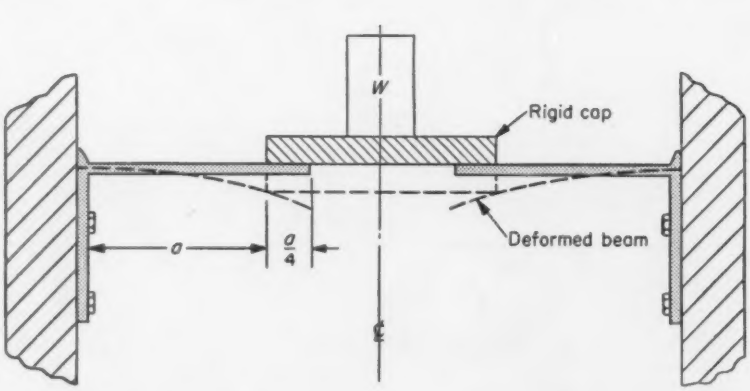


Fig. 4 — Concentrated load, supported symmetrically by a rigid cap on two angle-section flanges

deflection under the load? What would be the frequency of vibration?

The moment of inertia of the cross-section is $I = bh^3/12 = 1(1/4)^3/12 = 0.0013$ in.^{4} The length of the beam is 20 in. and the a/l ratio is 0.6. This beam is recognized as Case 2, and from Fig. 2, an a/l ratio of 0.6 gives $K_a/K_r = 220$. Therefore,

$$K_a = 220\,K_r = \frac{220(30)\,(10^6)\,(0.0013)}{20^3} = 1075 \text{ lb per in.}$$

and for the 50-lb load, the deflection is $\delta = Q_a/K_a = 50/1075 = 0.0465$ in.

To determine the natural frequency,

$$f = \frac{1}{2\pi}\sqrt{\frac{g}{\delta_{st}}}$$

where δ_{st} is the static deflection under the load and $g = 386$ in. per sec.^{2} Hence, for this example, the natural frequency of vibration is

$$f = \frac{1}{2\pi}\sqrt{\frac{386}{0.0465}} = 14.5 \text{ cps}$$

Example 2: A load W is exerted symmetrically through a rigid cap on two flanges of angle sections in a mechanical structure, Fig. 4. What is the deflection of the cap? The load applied to a single beam-spring is $W/2$. The type of beam arrangement is Case 4, with $l = 1.25a$ and $a/l = 0.8$. For an a/l ratio of 0.8, the stiffness ratio, Fig. 2, is 5.85. The deflection then becomes

$$\delta = \frac{W/2}{K_a} = \frac{W/2}{5.85\,K_r} = \frac{W l^3}{11.7EI} = \frac{0.167\,Wa^3}{EI}$$

Other deflection and vibration problems can be solved in a similar manner by using the charts in Fig. 2.

REFERENCES

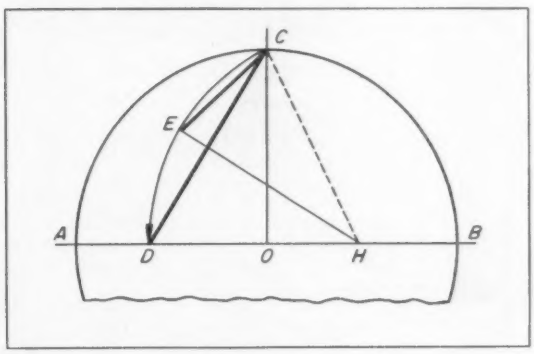
1. A. H. Church—*Mechanical Vibrations*, First Edition, John Wiley and Sons Inc., 1957, Chapter II.
2. S. Timoshenko—*Strength of Materials*, Part I, Second Edition, D. Van Nostrand Co., 1940, Chapters V and VI.

Tips and Techniques

Pentagon Construction

This simple geometric construction provides an accurate method for laying out a regular pentagon or decagon.

1. Construct a circle and draw diameter *AOB*.
2. Construct vertical *OC*.
3. Locate midpoint *H* on radius *OB*.
4. With *H* as center and *HC* as radius, draw arc *CD*.



5. The chord distance *CD* is the side length of the regular pentagon.
6. To find the side length of a decagon, construct the normal to chord *CD* from *H* and extend to *E* on arc *CD*.
7. *CE* is now the arc over one side of a regular decagon.

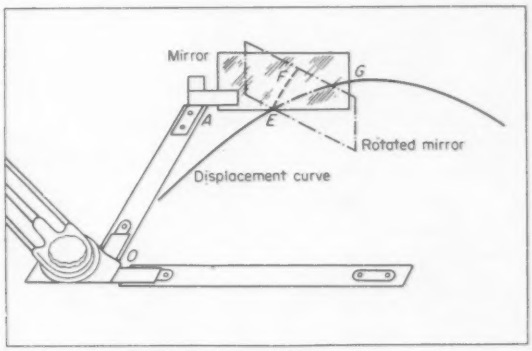
—A. E. HOCHSTEIN, *Strong Electric Corp., Toledo, Ohio.*

EDITOR'S NOTE

Other polygon construction methods are described in the January 23, 1958 issue of MACHINE DESIGN on Page 144.

Differentiator

This procedure for finding the slope of a line, required when differentiating displacement or velocity diagrams, makes use of the mirror-image method to locate the slope. In addition, it permits the slope



line to be drawn without moving the mirror.

A mirror is incorporated in a holder rigidly fastened to a drafting machine rule at *A*. When the mirror is held on the curve, a distorted line, *EF*, is viewed. The machine is moved around until *EF* becomes the continuous line *EG*. The slope line is then drawn along the edge of the rule *OA*.—MICHAEL W. SCHWETZ, *senior design engineer, American Type Founders Co. Inc., Elizabeth, N. J.*

Do you have a helpful tip or technique for our other readers? You'll receive ten dollars or more for each published contribution. Send a short description plus drawings, tables, or photos to: Tips and Techniques Editor, MACHINE DESIGN, Penton Bldg., Cleveland 13, O.

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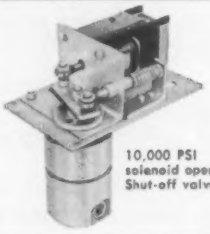

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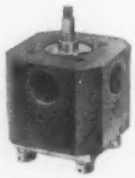
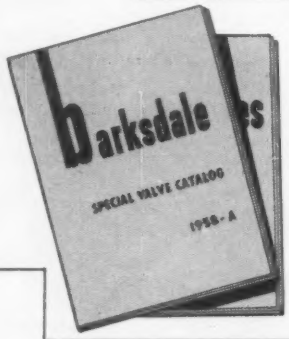
3000 PSI 3-way explosion-proof solenoid valve with manual override.

3000 PSI inline manual shut-off valve.

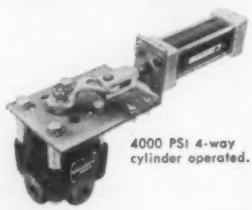
3000 PSI Dual 3-way, 3-position manual non inter-flow valve.



3000 PSI 4-way non inter-flow manual valve built to military specifications.



1500 PSI 4-way spring centered manual valve with built in cylinder relief and pressure relief valves.



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1500 PSI 4-way spring centered manual valve with built in cylinder relief valve.

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Circle 481 on Page 19

DESIGN ABSTRACTS

electrical

Electrical Strain Measurements At High Temperatures

J. E. Starr, Tatnall Measuring Systems Co.

Principles of the bonded electrical resistance strain gage. Types of gages and advantages of each in various high-temperature applications are covered. Gage sensitivity, suitable gage alloys, and lead wire considerations are included. Electrical property data of the gage alloys and lead wire materials are summarized.

ASM paper, Proceedings of the First Southwestern Metal Conference, Dallas, Tex., 1958; *pp.* 37-50.

High Temperature, High Energy Electronic Resistors

A summary of the unusual qualities of recrystallized silicon carbides which make the material suitable for new electronic applications. Electrical properties of the material are due to volume characteristics of the silicon carbide, rather than to surface phenomena as is common in the usual bonded ceramic resistors. Available resistor forms are illustrated and potential applications covered.

Advanced Materials Technology, *Volume* 1, *No.* 4, *September*, 1958; *pp.* 6-7.

Sealed Power Transformers

E. W. Tipton, Westinghouse Electric Corp.

A presentation of transformer designs which have resulted from attempts to slow down insulation deterioration. How various oil-protection schemes either make use of, or render harmless, the phenomenon of breathing.

Westinghouse Engineer, *Vol.* 18, *No.* 5, *September*, 1958; *p.* 152-155.

materials

High-Temperature Strength of Aluminum and Alloys

N. P. Inglis and E. C. Larke

Report of short-time tensile, stress-rupture, and creep tests on pure aluminum and aluminum alloys common to the engineering field. Data were recorded for conditions to 500 F. Stress-temperature curves are plotted which allow a direct comparison to be made of the effect of temperature on rupture strength for specified periods of time. A report of the effect of time, stress, and temperature on microstructure and types of fracture is included.

From a paper prepared for the Institution of Mechanical Engineers (Great Britain); 11 *pp.*

Cast Ceramic Fiber Insulation

A brief report of the development of a ceramic insulating material that extends the temperature range of fiber products above the limits of mineral wools, glass fibers, and asbestos. The material, made of aluminum oxide and silica sand, can be used in bulk, made into blocks and boards, paper, pads and blankets, and woven into rope and textile forms. These products have low heat capacity, are excellent high-temperature insulators, and are completely resistant to thermal shock. In specialized applications, the material can withstand temperatures to 5000 F for short durations. Areas of application are suggested.

Advanced Materials Technology, *Volume* 1, *No.* 4, *September*, 1958; *pp.* 4-5.

Economics of Magnesium For Various Applications

R. G. Gillespie, Brooks & Perkins Inc.

An evaluation of economic factors which govern the selection of different materials for various applications. Magnesium is compared to other materials on the basis of costs, application potentials, machinability, and other workability characteristics. Cost of materials, tooling costs, fabrication and assembly costs, and operating costs during the useful life of the product are evaluated from a design standpoint.

Magnesium Association Fourteenth Annual Convention, Detroit, October, 1958; 21 *pp.*

Magnesium Finishing

John A. Stevens, The Dow Chemical Co.

How design engineers can combat corrosion. Part 1 of this two-part series describes major criteria for corrosion. It offers a method which enables the engineer to predict in-service corrosion with as much reliability as he can predict environmental factors. It also indicates respective areas of corrosion responsibility of the process engineer and design engineer. Basic terms of corrosion are defined.

Magnesium Topics, *Vol.* 9, *No.* 4, *October*, 1958; *pp.* 6-7.

Properties and Applications of Stainless-Steel Sheet

R. W. White, Chance Vought Aircraft

A discussion of the properties of 17-7PH and other precipitation-hardening stainless-steel sheets in various airframe applications. Included are heat treatment data for PH stainless steels, general applicability of stainless-steel sheet, and methods of processing these stainless steels.

ASM paper, Proceedings of the First Southwestern Metal Conference, Dallas, Tex., 1958; pp. 1-9.

Magnesium Alloys in Ramjet Applications

C. P. King, Marquardt Aircraft Co.

A comparison of the properties of HN21A and HK31A magnesium-thorium sheet alloys used in ramjet engines. Experiences gained in the production use of HN21A are reviewed and general characteristics of the alloy when it is being formed and fabricated are described. Reasons for selecting the new HN21A as a replacement for HK31A are discussed. Also compared are fusion welding characteristics, resistance welding characteristics, formability, corrosion properties, and applicability of chemical milling.

Magnesium Association Fourteenth Annual Convention, Detroit, October, 1958; 5 pp.

Structural Applications of Inconel X

R. R. Ferguson, North American Aviation Inc.

A brief discussion of the applicability of Inconel X to aircraft and similar structures. Heat treatment, aging treatment, and stress relieving are considered. Welding and machining methods and formability practices are discussed.

ASTE paper 178, American Society of Tool Engineers Semi-Annual Meeting, Los Angeles, October, 1958; 9 pp.

The Status of Magnesium In Automotive Applications

E. L. Schaper, and H. A. Schertel, The Dow Chemical Co.

Where and how magnesium is used in present automotive applications and how magnesium castings have reduced weight of major components are covered. Design considerations for the castings and potential applications of magnesium are included.

Magnesium Association Fourteenth Annual Convention, Detroit, October, 1958; 8 pp.

Vibration Damping Capacity Of Magnesium Alloys

D. F. Walsh, J. W. Jensen, and J. A. Rowland, U.S. Dept. of the Interior

A report on damping capacity of a number of magnesium-base alloys of both commercial and experimental compositions. A correlation between damping capacity of the material and its composition is shown. For purposes of comparison, damping capacities for cast magnesium and for a number of well known commercial alloys are included. How magnesium alloys can be selected to provide any reasonable degree of damping capacity at an appropriate stress level is discussed.

Magnesium Association Fourteenth Annual Convention, Detroit, October, 1958; 6 pp.

processes

Precision Cold Extrusion of High-Temperature Metals

R. A. Quadt, Bridgeport Brass Co.

Aspects of the current technology of cold extrusion of some newer metals. Descriptions of the results of work on molybdenum, zirconium, Zircaloy, titanium, uranium, columbium, and alloy steels are included. Advantages and limitations of the process are described and range of sizes of extrusions that appear feasible is covered. Mechanical and metallurgical properties are summarized.

ASTE paper 167, American Society of Tool Engineers Semi-Annual Meeting, Los Angeles, October, 1958; 8 pp.

Fabrication of Beryllium

K. G. Wikle, Brush Beryllium Co.

A description of the beryllium presently available for structural use, methods used to fabricate it into primary shapes and final useful forms, limitations of fabrication, and applications. Physical properties of beryllium in various forms are included. Other mechanical data include tensile properties of powdered beryllium, compression, shear, and impact properties, creep properties, and strength characteristics of beryllium lap joints fastened with standard bolts. Fabrication techniques and methods of joining are included.

ASTE paper 176, American Society of Tool Engineers Semi-Annual Meeting, Los Angeles, October, 1958; 16 pp.

Metal-Forming Techniques

F. G. Helander, Baldwin-Lima-Hamilton Corp.

A brief description of high-pressure rubber forming and roll forming of large high-strength sheet-metal parts. Advantages and limitations of the processes are included.

ASTE paper 167, American Society of Tool Engineers Semi-Annual Meeting, Los Angeles, October, 1958; 5 pp.

Fabricating Techniques for High-Strength Superalloys

H. E. Haley, Haynes Stellite Co.

Classification and discussion of superalloys required to operate at temperatures from 1200 F to temperatures within 100 deg of their melting points. Physical and mechanical properties data are given for Fe-base, Ni-Mo, Ni-Mo-Cr, Ni-Cr-Fe-Mo, and Co-Cr-W-Ni alloys. Discussions include welding of these alloys, surface preparation, joint design and edge preparation, methods of forming and heat treating, and preparations for forging operations.

ASTE paper 175, American Society of Tool Engineers Semi-Annual Meeting, Los Angeles, October, 1958; 13 pp.

TO OBTAIN COPIES of papers or articles abstracted here, write directly to the following organizations:

ASM—American Society for Metals, 7301 Euclid Ave., Cleveland 3, Ohio.

Advanced Materials Technology, The Carborundum Co., New Products Branch, Research & Development Div., Niagara Falls, N. Y.

Westinghouse Engineer, P. O. Box 2278, 3 Gateway Center, Pittsburgh 30, Pa.

The Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, SW 1.

The Magnesium Association, 122 East 42nd St., New York 17, N. Y.

Magnesium Topics—The Dow Chemical Co., Midland, Mich.

ASTE—American Society of Tool Engineers, 10700 Puritan Ave., Detroit 38, Mich.

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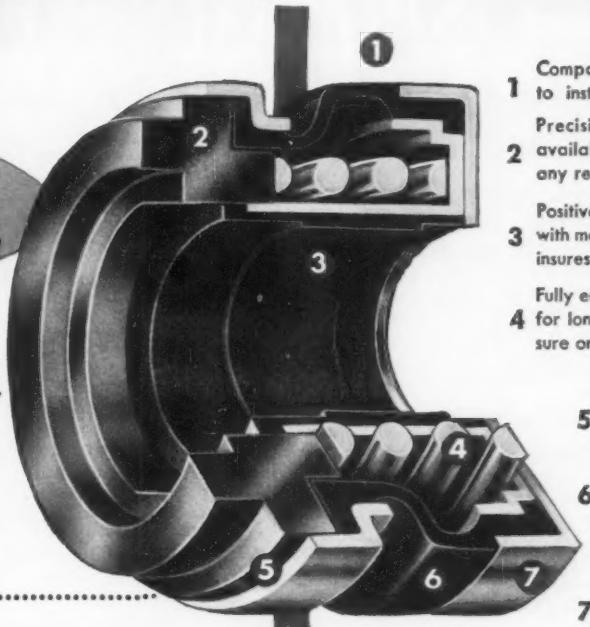

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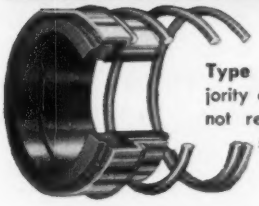

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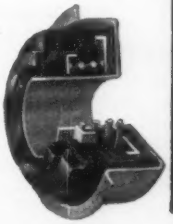

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Circle 482 on Page 19

Helpful Literature
for Design Executives

For copies of any literature listed, circle Item Number on Yellow Card—page 19

Tube, Pipe & Their Fittings

A cross reference between the type of steel, the application, and the specifications of various types of carbon, alloy, and stainless steel tubing, pipe, seamless welding fittings, and flanges is purpose of Bulletin TDC-186 A. 4 pages. Babcock & Wilcox Co., Tubular Products Div., Beaver Falls, Pa. G

Circle 631 on Page 19

Precision Gages & Tools

Photos and digest descriptions of optical, electronic, and mechanical types of precision tools, gages, and inspection devices are found in catalog. They measure microinches, fractional seconds of arc, alignment, parallelism, roundness, etc. 12 pages. Engis Equipment Co., 431 S. Dearborn St., Chicago 5, Ill. I

Circle 632 on Page 19

Process Instruments

Among the standardized process instruments described and illustrated in Catalog 2 are indicators, transmitters, recorders, and controllers for flow, pressure, temperature, density, viscosity, and consistency. Specifications of all equipment are given. 52 pages. Fischer & Porter Co., 941 Jacksonville Rd., Hatboro, Pa. E

Circle 633 on Page 19

Pump & Motor Units

Compact Series T integral pump and motor units for hydraulic, pressure feed, and transfer work are described and illustrated in Bulletin 31. Capacities are 0.3 to 55 gpm at rated maximum pressure. Performance and dimensional data are included. 8 pages. Roper Hydraulics, Inc., Rockford, Ill. K

Circle 634 on Page 19

Pressure Primer

Operation of the Mini-Ram pressure primer, used with a Lincoln air motor pump to dispense heavy lubricants, mastics, sealers, and coatings, is described in Bulletin 683. Unit dispenses from original 5-gal containers. Control valves, flow guns, and extension nozzles are also covered. 2 pages. Lincoln Engineering Co., 5736 Natural Bridge Ave., St. Louis 20, Mo. I

Circle 635 on Page 19

Transformers

Details of over 450 stock transformers are contained in Catalog CT8-58. Electrical and physical specifications on military standard 400-cycle and many other hermetically sealed units are presented, as well as data on transformers for transistor, communications, and industrial uses. 32 pages. Chicago Standard Transformer Corp., 3501 W. Addison St., Chicago 18, Ill. J

Circle 636 on Page 19

Accelerometers

Concept of utilizing gas as the damping medium for dynamic measuring devices is outlined in Instrument Notes No. 33, "Some Characteristics of Gas-Damped Accelerometers." They have a wide temperature operational range. 4 pages. Statham Instruments, Inc., 12401 W. Olympic Blvd., Los Angeles 64, Calif. L

Circle 637 on Page 19

Power Supplies

Standard line of 0 to 32-v dc power supplies, with current ratings from 5 to 40 amp, is subject of Data Sheet 102. Eight models for rack and bench use operate from 115 v 60 cycles, single phase. 2 pages. Opad Electric Co., 69 Murray St., New York 7, N. Y. D

Circle 638 on Page 19

Steel Bars

Improvements in high-strength, free-machining Stressproof steel bars are outlined in bulletin. Physical properties compare with those obtained by heat treating. Copper-bearing material has 100,000-psi yield strength. 4 pages. La Salle Steel Co., Box 6800-A, Chicago 80, Ill. J

Circle 639 on Page 19

Socket Screws

Setko socket shoulder screws, flat heads, button heads, and dowel pins are new products introduced in illustrated Catalog 23. Also shown is expanded line of "perfect hole" cold forged socket head cap screws. A self-locking set screw selector chart included covers a wide variety of other fasteners. 28 pages. Set Screw & Mfg. Co., Bartlett, Ill. I

Circle 640 on Page 19

Magnetic Amplifiers

Missile guidance, automatic pilots, industrial controls, monitoring systems, nuclear measurements, and electro-hydraulic servo valves are applications for the Standard Series 400 cps magnetic amplifiers detailed in Bulletin 401-A. Basic circuits and typical uses are shown in drawing form. 4 pages. Acromag, Inc., 22519 Telegraph Rd., Detroit 41, Mich. H

Circle 641 on Page 19

Circuit Breakers

Single, two, and three-pole Stab-lok circuit breakers and enclosures are described in detail, illustrated, and their wiring diagrams included in Catalog 1-125R. Enclosures covered include load centers, split bus panels, main disconnect panels, and devices for special applications. Specifications of all units are given. 36 pages. Federal Pacific Electric Co., 50 Paris St., Newark 1, N. J. C

Circle 642 on Page 19

Rotameter

O-ring seal type of rotameter features Teflon tube adapters designed to permit easy removal and interchange of different sizes of metering tubes. Specification Sheet SS-111-2 gives design, capacity, and dimension details. 4 pages. Brooks Rotameter Co., Lansdale, Pa. E

Circle 643 on Page 19

Centrifugal Casting

Centrifugal casting process is described and illustrated with 22 photos in folder which details the production steps involved. New metals and alloys used are listed, and various shapes and sizes which can be cast are covered. 8 pages. Centrifugal Casting Co., 3245 Cherry Ave., Long Beach, Calif. L

Circle 644 on Page 19

Metal Hose Connectors

Large selection of Cobra standard flexible metal hose connectors is illustrated, described, and priced in Catalog 658. Specifications are also included for flexible nipples, pipe, pump connectors, vibration absorbers, and other products made of various metals. 16 pages. Cobra Metal Hose, 5059 S. Kedzie Ave., Chicago 32, Ill. J

Circle 645 on Page 19

Retaining Rings

Selector guides for 20 standard Waldes Truarc retaining ring series and 30 special rings are contained in illustrated Catalog RR 10-58. Purpose and function of each type are given. They accommodate shafts, bores, and housings ranging in diameter from 0.040 to 10 in. Typical uses and a section devoted to assembly tools complete the catalog. 24 pages. Waldes Kohinoor, Inc., 47-16 Austel Place, Long Island City 1, N. Y. C

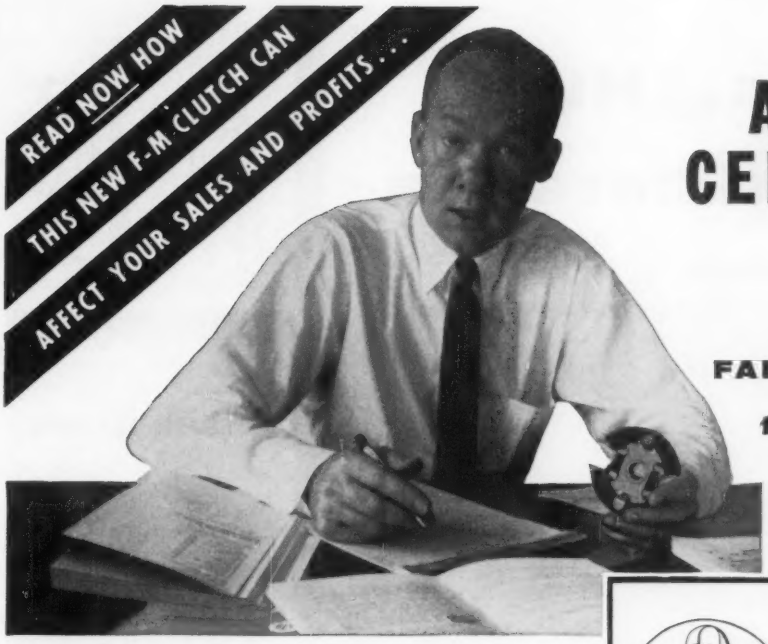
Circle 646 on Page 19

Synchronous Motors

Particular emphasis is given to the wide selection of hysteresis motors in Catalog EI-4 on Elinco synchronous motors. Detailed data cover over 200 representative motor designs. Information on theory and application of all types of synchronous motors is provided. 28 pages. Electric Indicator Co., Camp Avenue, Stamford, Conn. B

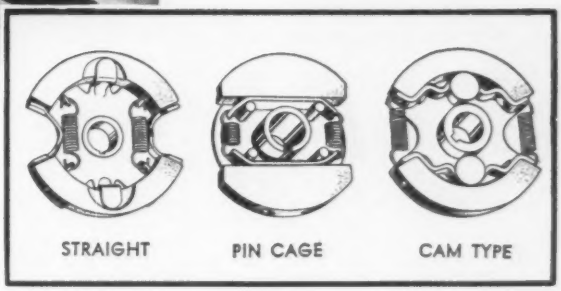
Circle 647 on Page 19

READ NOW HOW THIS NEW F-M CLUTCH CAN AFFECT YOUR SALES AND PROFITS . . .



A NEW AUTOMATIC CENTRIFUGAL CLUTCH

designed by FAIRBANKS-MORSE for the toughest usage you can name



Substantial cost savings for companies who can use it!

Here's an idea for engineers who want to reduce costs for profit improvement.

Simple design and high-volume production of these new clutches for motors and small gasoline engines mean substantial savings to you. And your quantity requirements make little difference in the cost.

If your equipment does not incorporate this starting feature, think of the benefits. Smaller motors can be used for *running* rather than starting loads. It provides low-line voltage protection on jobs where transmission lines are not adequate. You get smooth, gradual pick-up, and the motor is never called on to deliver power below its maximum torque speed. Starting current demand is reduced. It's a foolproof safety device — protects against stalling or overloads, yet does not slip at operating speed.

Gasoline engines may be started easier. The load is automatically applied at the engine's most efficient speed. It prevents stalling and accidental equipment damage.

The new clutch is manufactured in three types — all can be used with a pulley, sprocket, gear, or coupling-type drive on machinery, appliances, and gasoline engine equipment — any application on which automatic start and stop applies. If you already make or buy clutches, couplings, or drives for no-load starting and idling or overload protection, write for Fairbanks-Morse prices and evaluate the cost savings.

- **Simple and dependable—only four moving parts**
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- **Operates in either direction**
- **Mounts in any position, as clutch or sheave**
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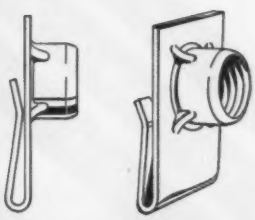
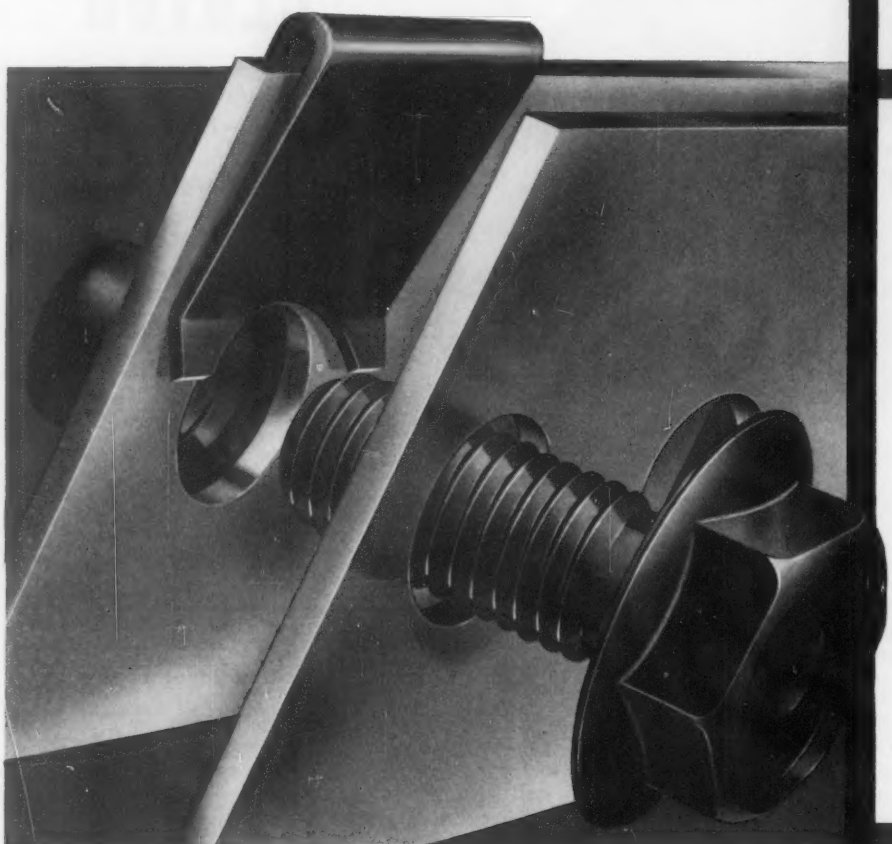
MAGNETOS • REWIND AND ELECTRIC STARTERS • WATER SYSTEMS • GENERATING SETS • PUMPS • MOTORS • SCALES • DIESEL LOCOMOTIVES AND ENGINES

Circle 483 on Page 19

DOT makes J NUTS with a difference





- FLUSH SEATING
- SELF-RETAINING
- SELF-TENSIONING
- LOW COST
- CAREFUL WORKMANSHIP

It takes a little extra care in the drawing operation to make really reliable J-nuts in volume but it's well worth the trouble. It reduces internal strains in the barrel so that DOT J-nuts stand up to working loads considerably better than the average fastener of similar construction.

Available in three thread sizes (5/16″-18 and 24, 1/4-20) and to fit three ranges of material thickness (.030″ to .065″), DOT J-nuts are made of carbon steel. They hold themselves in place over stamped holes so that preassembly is practical in cases where the actual bolting operation comes at the end of a series of other operations.

Full details on request.

CARR FASTENER COMPANY

Division of United-Carr Fastener Corporation, Cambridge 42, Mass.

MAKERS OF DOT FASTENERS

Circle 484 on Page 19

Tool Steels

Comparable brand names of 13 major tool steel suppliers are listed on this chart by general type and SAE number. Sixteen different grades are covered. Chart is punched for a ring binder, or it can be used as a wall chart. 4 pages. Uddeholm Co. of America, 155 E. 44th St., New York 17, N. Y. D

Circle 648 on Page 19

Gears

Plant and quality control facilities for the production of custom gears are described and illustrated in Bulletin 26IG which presents data on capacities, types, processes, materials, heat treatment, and equipment. 12 pages. Illinois Gear & Machine Co., 2108 N. Natchez Ave., Chicago 35, Ill. J

Circle 649 on Page 19

Reinforced Plastics

Wide variety of products molded of Fiberglas reinforced plastic are described and illustrated in two bulletins. Available materials, molding methods and their advantages, design considerations, and service offered by this company are covered. 4 and 8 pages. Winner Mfg. Co., 100 Sullivan Way, Trenton 3, N. J. E

Circle 650 on Page 19

Servo Motors

Application data for standard and custom servo motors, including schematics of motors operating direct plate to plate, with transistorized amplifiers and magnetic amplifiers, are found in Bulletin 385A. Characteristics and installation drawings are included from size 08 to 23 units. Gear servo motors are included. 10 pages. United Aircraft Corp., Norden Div., Commack, L. I., N. Y. D

Circle 651 on Page 19

Gasoline Engines

Installation diagrams, general data, and specifications are provided by five revised data bulletins on the 143-hp Model RXC, 226-hp Model HXE, 131-hp Model JXLD, 91-hp Model QXLD, and 139-hp Model WXLC-3 six-cylinder gasoline engines. 2 pages each. Hercules Motors Corp., Canton, Ohio. G

Circle 652 on Page 19

Telephone Batteries

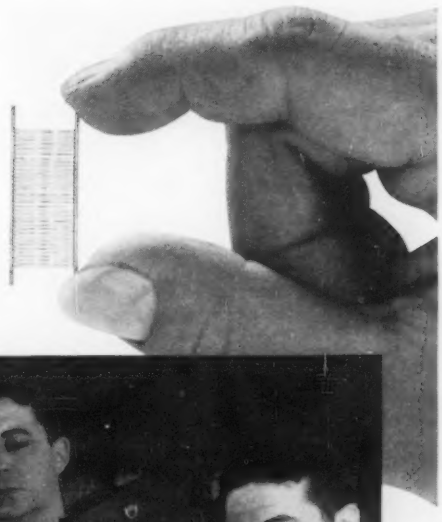
Quick selector chart featured in Bulletin 6212 on Exide telephone batteries simplifies picking out the right battery for any type service requirement. Units cover 8-24 to 4000-7000 amp-hr range. Spiral-wound, lead-button construction of plate is shown. 4 pages. Electric Storage Battery Co., Box 8109, Philadelphia, Pa. E

Circle 653 on Page 19

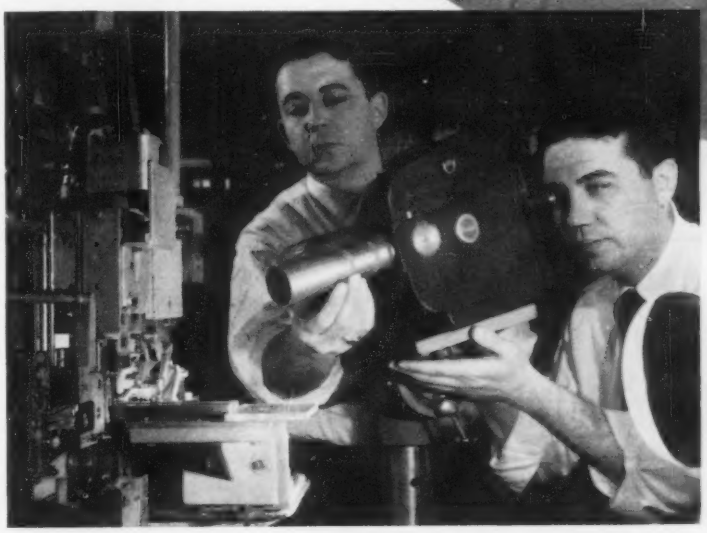
Stainless Duct & Bellows

Stainless steel ducting and bellows components reviewed in Form 500 are used in turbo-jet and turbo-prop aircraft pneumatic (bleed air) systems. Pressure compensating chambers are also covered. 4 pages. Arrowhead Rubber Co., 2330 Curry St., Long Beach, Calif. L

Circle 654 on Page 19



TO SPACE
THESE GRID WIRES
PRECISELY...



RCA "MAGNIFIED TIME"
WITH THE KODAK HIGH SPEED CAMERA

In setting up high speed equipment for the production of vacuum tube grids, RCA engineers developed automatic machinery for rapid welding of the tiny wires and found they could eliminate the "cut-and-try" method of checking the tooling by using the Kodak High Speed Camera.

One of the first problems encountered was uneven spacing. Because the welding process moved too fast to follow with the naked eye, the engineers made high speed movies of it with the Kodak High Speed Camera. Projecting the film at *normal* speed slowed action down—"magnified time"—and showed that:

1) some slots in the spacing comb were improperly cut, and

2) a mandrel, withdrawn after the welds were made, was dragging wires with it.

Based on an analysis of the films, a new comb was fabricated. And action of the mandrel was modified, eliminating drag. The problem was solved quickly—without costly cut-and-try experimentation.

Where can you use high speed movies? Wherever you have trouble caused by motion that's lost in a blur of speed. With the Kodak High Speed Camera and Kodak Film you get a record of *time magnified*. On the screen, action is slowed down as much as 200 times. And you can study the films as often as needed.

If you'd like to know more about this analytic tool, send for "High Speed Movies in the Service of the Engineer." For your free copy, write to:

EASTMAN KODAK COMPANY, Rochester 4, N. Y.

the Kodak
HIGH SPEED Camera

Kodak
TRADE MARK

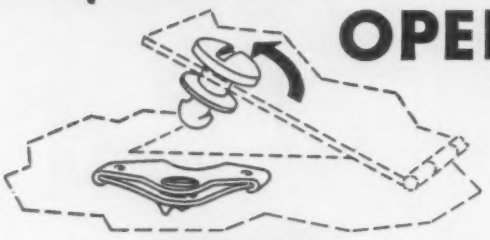
Circle 485 on Page 19

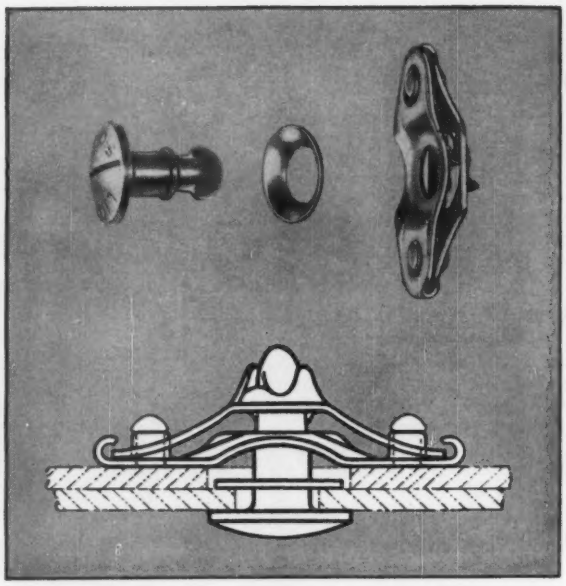
One-quarter turn . . .

CLOSED

One-quarter turn . . .

OPEN





LION QUARTER-TURN FASTENERS

QUICK TO INSTALL

Lion Fasteners can be installed rapidly. Studs simply slip through drilled hole and are retained by a grommet. Springs are riveted or spot-welded in place.

RUGGED

Lion Fasteners stand up under the most rugged conditions of shear, tension, and vibration . . . meet or exceed the exacting requirements of Army-Navy-Air Force Specifications MIL-F-5591A (ASG) and have Civil Aeronautics Administration approval for civilian aircraft use.

LIGHTWEIGHT

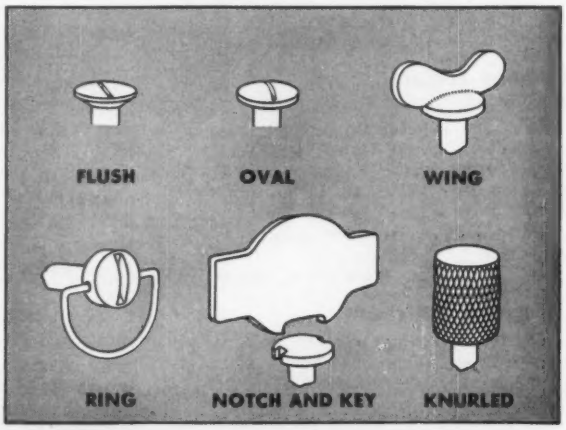
Made of cadmium-plated steel to provide a high strength-low weight ratio, No. 5 Fasteners weigh only 12 to 14 lbs. per 1000; No. 2 Fasteners 7 to 8 lbs. per 1000; No. H Fasteners approximately 35 lbs. per 1000.

VIBRATION-PROOF

This group of fasteners is particularly suited to metal fastening conditions where vibration is an important factor. Lion Fasteners can't shake loose . . . can't open by themselves.

FULL RANGE OF HEADS...

The Lion No. 5 Fastener is available with flush, oval, ring, wing, knurled, or notched head and key; No. 2 Fastener is available with flush, oval, or wing type head; the No. H Fastener comes with an oval head.



LION *Quarter-Turn* **FASTENERS**

For complete information on Lion Quarter-Turn Fasteners, as well as on the complete Southco line, write today to Southco Division, South Chester Corporation, 237 Industrial Highway, Lester, Pa.

SOUTHCO FASTENERS

LION

© 1956

Nylon Parts

How to get short-run nylon parts at an average tooling cost of $300 to $500 is related in folder. It describes the Process N technique that gives customers requiring 15,000 to 50,000 small nylon parts what they need at advantageous prices. 4 pages. Nylon Molded Products Corp., Garrettsville, Ohio. G

Circle 655 on Page 19

Structural Alloy Facilities

Facilities of company's Aristoloy Steel Div. reviewed in booklet include melting, lead treating, ingot heating, a 35-in. blooming mill, metallurgical and chemical control, rolling mills, conditioning, finishing mill, thermal treatment, and cold finishing. It tabulates chemical compositions, ranges, and limits of various steel alloys. 48 pages. Copperweld Steel Co., Aristoloy Steel Div., Warren, Ohio. G

Circle 656 on Page 19

Air & Hydraulic Cylinders

Bulletins 200, 1000, and 1800 provide dimensional, mounting, and parts information on 200-psi air cylinders, 1000-psi medium duty hydraulic cylinders, and 1800-psi heavy duty hydraulic cylinders, respectively. 4 pages each. Bendix-Westinghouse Automotive Air Brake Co., Elyria, Ohio. G

Circle 657 on Page 19

Solenoid Valves

Series A packless 2 and 3-way solenoid valves and Series B midget solenoid valves with 2-way normally closed operation are reviewed as to specifications, flow patterns, and performance in Form 914. Valves can be used with air, water, oils, and gases. 8 pages. C. A. Norgren Co., 3400 S. Elati St., Englewood, Colo. K

Circle 658 on Page 19

Tube or Rod Fastener

Locking key principle of the Barr-Bushing is effectively explained in small bulletin. The Barr-Bushing mechanically holds rod or tube which passes through a wall or panel. They are custom made to size. 4 pages. Denver Metals & Chemicals Corp., Barr Machine & Tool Div., 2130 S. Platte River Dr., Denver 23, Colo. K

Circle 659 on Page 19

Explosionproof Housings

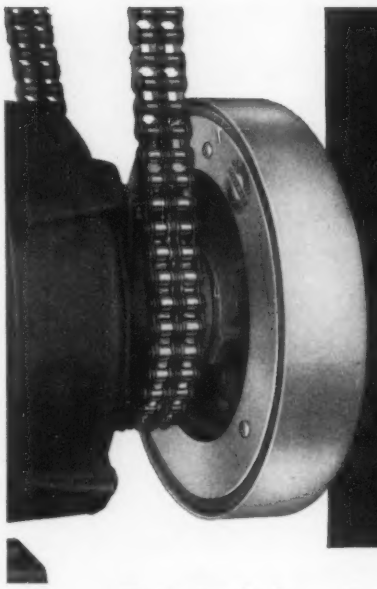
Cast-aluminum weatherproof as well as explosionproof housings for electrical equipment, controls, and wiring are subject of Bulletin 158. Junction boxes and housings with various mounting means are described. 16 pages. Adalet Mfg. Co., 14300 Lorain Ave., Cleveland 11, Ohio. F

Circle 660 on Page 19

Teflon Tapes

Temp-R-Tape pressure-sensitive Teflon tapes and thermal curing Teflon tapes for —100 to 500° F electrical and mechanical applications are subject of descriptive data sheet. Highlight of folder is a typical properties chart for five types. 4 pages. Connecticut Hard Rubber Co., 407 East St., New Haven 9, Conn. B

Circle 661 on Page 19



COMPARE!
ONLY
Whitney-TORMAG
DRIVE
GIVES COMPLETE
MOTOR-DRIVE
PROTECTION!

From Overloads — Costly Damage — Downtime

Whitney-Tormag Drive gives you everything you've been looking for in a protective drive. You get smooth, cushioned starts, complete protection from overloads and damage caused by stalls and jamming. *Plus*, a Whitney-Tormag Drive is the only self-contained unit which will run under *full stall conditions for extended periods*... without overheating or overloading the motor or driven equipment. And Magnetic Torque never wears out — permanent magnets eliminate fluids, particles, seals and pumps ... cuts power drainage!

SEE HOW WHITNEY-TORMAG DRIVES MEET EVERY REQUIREMENT!

FEATURES	Whitney-Tormag Drives	Shot Loaded Centrifugal Drives	Fluid Loaded Drives
Torque Limiting (independent of input speed)	Yes	No	No
Overload Protection (under full stall)	Yes	No	No
Indefinite Full Stall	Yes	No	No
Shock Absorbing	Yes	Partial	Yes
No Wearing Surfaces	Yes	No	Yes
One Design for All Installations	Yes	No	Yes
Smooth Load Pickup	Yes	Variable	Yes
Independent of Input Speed	Yes	No	No
Independent of Direction & Frequency of Reversal	Yes	No	No

Whitney-Tormag Drives are available through your local Whitney Chain Distributor in 1, 2, 3 and 5 H.P. (at 1750 RPM input) sizes, additional sizes up to 15 H.P. will follow.
Write for new catalog, giving complete description and details.

A PRODUCT OF Whitney • CHAIN COMPANY

304TC HAMILTON STREET • HARTFORD 2, CONNECTICUT

ROLLER CHAIN • CONVEYOR CHAIN • SPROCKETS • FLEXIBLE COUPLINGS • WHITNEY-TORMAG DRIVES

Circle 487 on Page 19

GEAR-GRIP

The most revolutionary Flexible Coupling Design Development in a century!

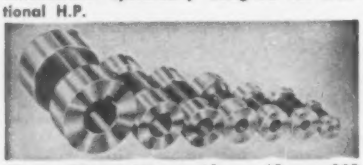
Now available for sub-fractional, fractional and integral H.P.

Ability of rubber Flex-Element to float between captive end fittings distributing load similar to universal joint action.

- LOAD RANGES—1/50 H.P. Thru 40 H.P.
- SHAFT SIZES—1/8" thru 1-7/8"
- COUPLING O.D.—.395" thru 3-7/8"
- Allowance of end thrust and specified exact over-all length per series among many design features.

Dyna-Line

The finest flexible coupling in single unit construction—specifically designed for fractional H.P.



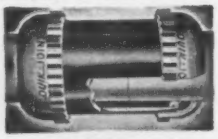
4R 3R 2R 1R OR 00R

- LOAD RANGES—1/15 H.P. thru 1-1/2 H.P.
- SHAFT SIZES—3/16" thru 3/4"
- COUPLING O. D.—11/16" thru 1-9/16"
- Lengths varied to design specification in each series.

Quick-Joint

Steel Compression Pipe Couplings

- Now available in straight couplings, 90° Elbows, Reducing couplings, Male Threaded Adapters and Compression Tees.
- ALLOWS 14° Angular Deflection
- Guaranteed for 2000 PSI
- No threading of pipe required
- Various gasket compounds to meet hazardous and volatile fluid conditions



Guardian
PRODUCTS CORP.
COUPLING DIVISION
Dept. M-128
Michigan City, Indiana

Circle 488 on Page 19

HELPFUL LITERATURE

Motorized Gear Drives

Line-A-Spede motorized gear drives are gear reducers powered by standard NEMA frame motors mounted on a shelf attached to the reducer. They use double, triple, and quadruple reduction units for ratios up to 1487 to 1 with motor ratings of 1 to 75 hp. Bulletin 2350 shows how drives facilitate standardization of motors. 4 pages. Louis Allis Co., 427 E. Stewart St., Milwaukee 1, Wis. K

Circle 662 on Page 19

Self-Locking Nut

PEM self-locking, self-clinching nuts provide load-bearing threads in thin sheet-metal products. The dual-locking feature is explained in Bulletin SL-858 along with sizes and lengths, mounting hole dimensions, and suggested installation forces. 4 pages. Penn Engineering & Mfg. Corp., Doylestown, Pa. E

Circle 663 on Page 19

Carbon & Graphite Equipment

A complete line of carbon, graphite, and impervious carbon and graphite equipment for chemical processing is discussed in Catalog Section S-5008. Covered are shell and tube heat exchangers; cascade, concentric, and immersion heat exchangers; centrifugal pumps; entrainment separators; pipe and fittings; brick; structural shapes; and cements. 4 pages. National Carbon Co., 535 Fifth Ave., New York 17, N. Y. C

Circle 664 on Page 19

Electric Strip Heaters

Bulletin F-1613 is a pictorial presentation on 32 uses of Chromolox electric strip heaters in industry. Both straight and curved elements are available for keeping viscous compounds moving smoothly, for oven and air heating, for heating tanks and containers, and for use in platens or other production equipment. 4 pages. Edwin I. Wiegand Co., 7500 Thomas Blvd., Pittsburgh 8, Pa. G

Circle 665 on Page 19

Reduced Voltage Starters

"Automatic Reduced Voltage Starters" is title of Bulletin 14B8192 which gives information on design and application of starters with ratings from 50 to 600 hp and voltages to 600 v. Technical data include starting characteristics calculations, horsepower ratings, and features of relays, contactors, and fuses. 12 pages. Allis-Chalmers Mfg. Co., Milwaukee 1, Wis. K

Circle 666 on Page 19

Cemented Carbides

Tools, blanks, and indexable inserts are some of the cemented carbide products catalogued in Bulletin C-16. Available grades, shapes, and sizes are listed, and pricing guidance is offered. Technical section features six special charts on proper feeds, speeds, and grades of carbide materials to use on various cutting operations. 32 pages. Allegheny Ludlum Steel Corp., Carmet Div., Oliver Bldg., Pittsburgh 22, Pa. F

Circle 667 on Page 19

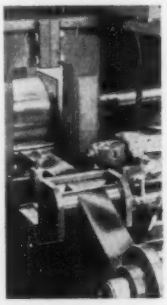
IT'S NOT "HOW THIN"

→ 0/8

BUT HOW EXACT!

With the recent trend in strip metal towards thinner and thinner gauges, Somers, a pioneer in thin strip for nearly 50 years, is naturally among the leaders in rolling *ultra-thin* strip. But in addition to rolling production quantities of strip as thin as can be obtained anywhere in the world, Somers utilizes exclusive techniques and equipment to make sure that every foot of metal is up to the most exacting standards.

1. Accu-Ray nuclear gauging to assure absolute uniformity of thickness throughout.



2. Unique rolling mill for strip from .001" down, makes possible extremely close control of the final pre-anneal temper, and uniform accuracy of the final temper.

NEARLY FIFTY YEARS

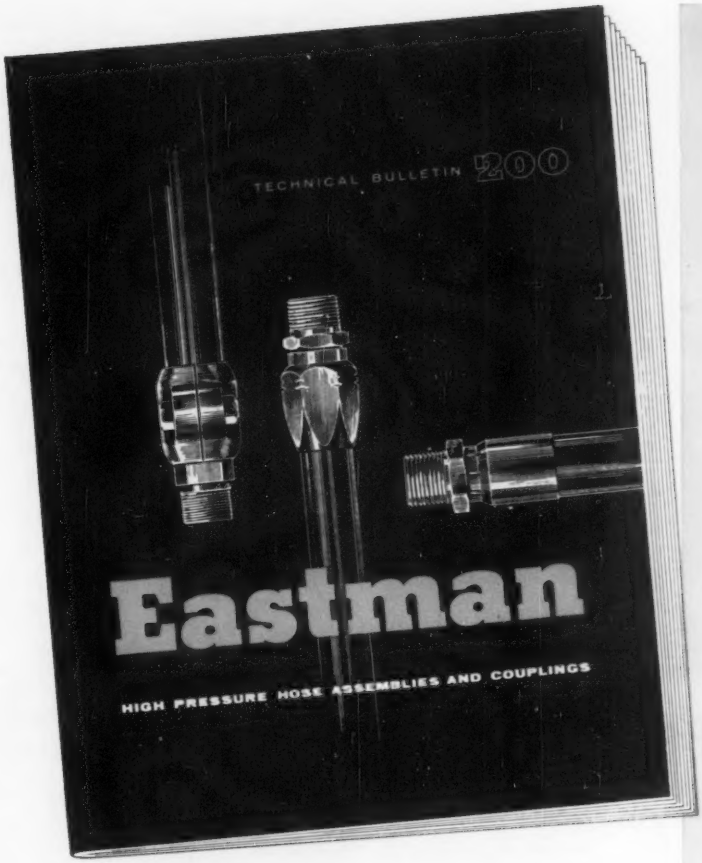
3. Experience exclusively with thin strip metals gives Somers an unmatched background in engineering *ultra-thin* strip to meet all special requirements.

FOR EXACTING STANDARDS ONLY

Somers

Somers Brass Company, Inc.
120 BALDWIN AVE., WATERBURY, CONN.

Circle 489 on Page 19



CONVENIENTLY ARRANGED TO HELP YOU MEET THE INCREASING DEMAND FOR HIGHER PRESSURES

Here's an entirely new service concept in catalog arrangement. It is designed to assist Engineers and Purchasing Agents in specifying Multi-Braid Hydraulic Hose and Tube Assemblies to meet the demand for increasing pressure requirements. With pressure as a primary consideration—the right assembly can be selected for the specific equipment on which it is to be used.

Nine major sections are devoted to assemblies suited to all types of high pressure hydraulic applications—complete with tables and specifications, including easy to read dimensional cross section drawings.

Include this new catalog in your files to make it easier to specify the proper assemblies.

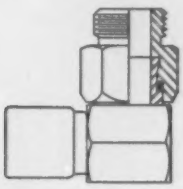
Write for Your Copy Today!

Eastman *first in the field* **MANUFACTURING COMPANY**
Dept. MD-12, MANITOWOC, WISCONSIN

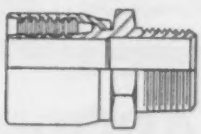
SAFEGUARDING AMERICA'S LIFELINES OF MOBILE POWER

AN INSIDE LOOK AT A *NEW BOOK*

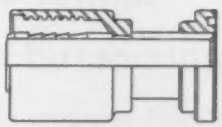
Eastman's new Technical Bulletin offers a new standard in simplified arrangement—for your convenience in specifying—according to your pressure requirements.



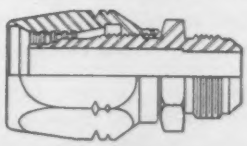
Swivel "O" Ring Male Couplings are available in 45° and 90° angles. Specifications on Page 13.



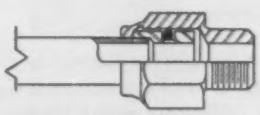
Permanently Attached Couplings for 2-wire braid hose. Specifications and Details on Page 10.



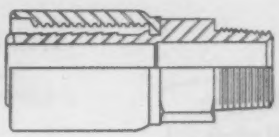
Permanently Attached Flange Head Couplings and Inserts from 0° to 90°. See complete list on Page 21.



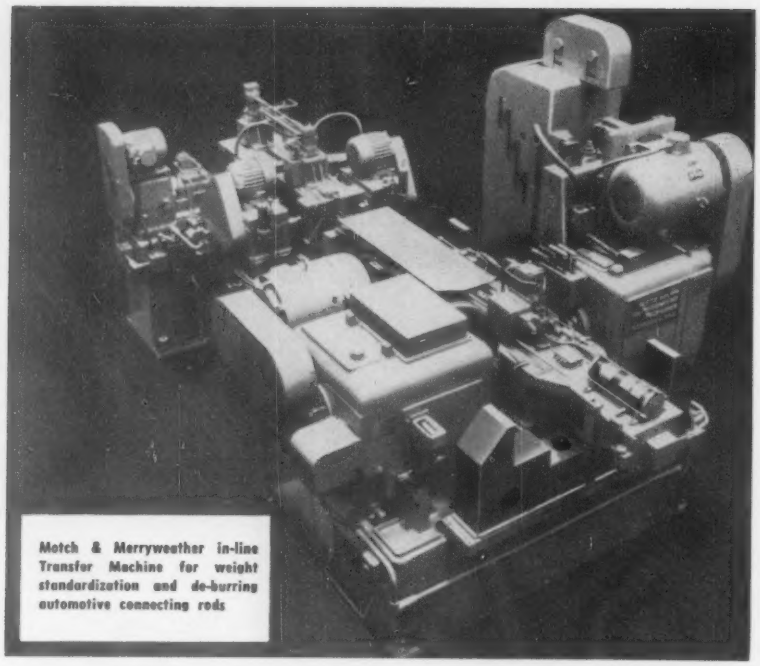
2-Piece Reusable Couplings for all high pressure hose. Used for pressures up to 5000 lbs. See Page 25.



Swivel Male Tube Nut "O" Ring Assembly used on formed tubing—described on Page 30.



Permanently Attached Couplings for **Extreme** High Pressures up to 7000 lbs. working pressure, Page 12.



Motch & Merryweather in-line Transfer Machine for weight standardization and de-burring automotive connecting rods

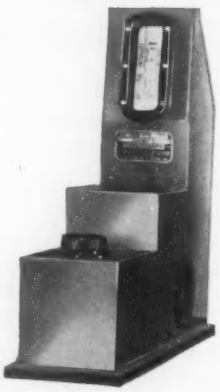
SHADOGRAPH® SCALES

control weight standardization for automated transfer machine

Production of automotive connecting rods increased from 150 to 320 rods per hour . . . quality and uniformity of product improved. These and other benefits are provided by the machine above equipped with Exact Weight Shadograph Scales.

In the machine's fast, automatic cycle, Shadograph Scales first weigh the rods for milling weight bosses on both ends. After milling operations, the rods are checkweighed and accepted or rejected for de-burring.

Exact Weight equipment is used in many types of automated machines including food packaging, metal working, meat slicing and plastics weigh feeders. Write for complete engineering data.



SHADOGRAPHS are available in models adapted to your particular needs. Capacities from 1 gram to 100 lbs.

THE EXACT WEIGHT SCALE CO.
923 W. FIFTH AVE., COLUMBUS 8, OHIO
In Canada: 5 Six Points Road, Toronto 18, Ont.

Exact Weight SCALES

Sales and Service Coast to Coast

Find us in your local "Yellow Pages"

BETTER QUALITY CONTROL . . . BETTER COST CONTROL

Circle 491 on Page 19

HELPFUL LITERATURE

Instrument Bearings

Details of a complete line of thin-section ball bearings, made in precision and ultraprecision grades to dimensions of the AFBMA B-500 Series, are presented in Catalog 59. Covered are twelve sizes from 0.625 to 3.0625-in. bore and 1.0625 to 3.875-in. OD. 24 pages. MPB, Inc., Split Ballbearing Div., Lebanon, N. H. B

Circle 668 on Page 19

Air & Hydraulic Control

Advantages, application information, and performance data on the new Quick-As-Wink poppet pilot B-type valve are contained in Bulletin 582. This ½-in. air-hydraulic control valve is offered in 2, 3, and 4-way designs with solenoids for any voltage. 4 pages. Hunt Valve Co., Salem, Ohio. G

Circle 669 on Page 19

Interval Timers

Automatic and manual reset, synchronous motor driven, interval timers are detailed in Bulletin 400. Timers are available with maximum cycles up to 30 minutes and can be supplied for 115 and 230-v, 25 to 400-cycle operation. 4 pages. Industrial Timer Corp., 1407 McCarter Highway, Newark 4, N. J. D

Circle 670 on Page 19

Paper-Base Laminate

Especially designed for printed circuit and other electronic applications, Grade EP-22 is a paper-base epoxy resin laminate. It is available in 1/32 to ¼-in. thickness and in 36 x 36 to 36 x 72-in. sheets. Complete physical and electrical properties are given in Bulletin EP-22. 1 page. Synthane Corp., Oaks, Pa. E

Circle 671 on Page 19

Punch Card Tool Control

Punch card machine tool positioning and programming is covered in Bulletin J 200 which describes the Shaftrol positioning gearmotor which is capable of providing resolution of 1 part in 1000 for each of its coarse and fine sensors. 2 pages. Jordan Co., 3235 W. Hampton Ave., Milwaukee 9, Wis. K

Circle 672 on Page 19

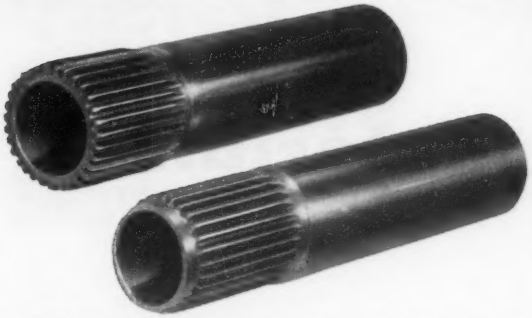
Electrical Controls

Pushbutton stations, speed-responsive switches, resistors, assembled controllers, contactors and relays, and drum controllers are among the many industrial controls covered with data and pictures in Bulletin 958. 8 pages. Euclid Electric & Mfg. Co., Madison, Ohio. F

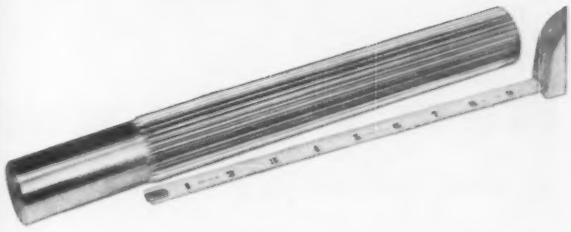
Circle 673 on Page 19

Servo Valves

Maximum rated flows to 10 gpm at 1000 psi with operating supply pressures from 500 to 4500 psi are available in line of flow control servo valves described in illustrated Catalog 220. Much technical data are included for aircraft, missile, nuclear, and industrial uses. 6 pages. Request on company letterhead from Moog Valve Co., East Aurora, N. Y. N



Tubular parts—*On even thin-walled tubes from ½ to 2-inches OD, splines and serrations can now be quickly and inexpensively Roto-Flo cold formed.*



Long splines—*can now be cold rolled on solid as well as tubular parts. 30° or 45° PA tooth forms can be made with this low-pressure method and axially fed parts.*

Announcing a NEW ROTO-FLO METHOD

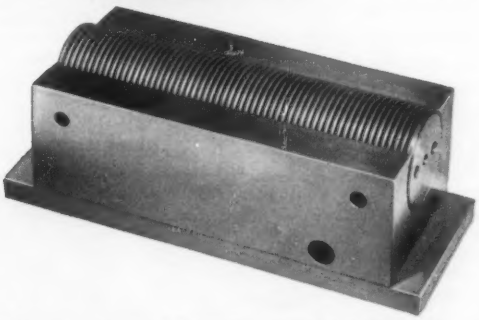
Now the **ROTO-FLO** chipless process that cold forms toothed parts faster at lower cost is extended to a broader range of parts. The development complements present Roto-Flo equipment.
Write for details!

–for spline rolling tubular parts

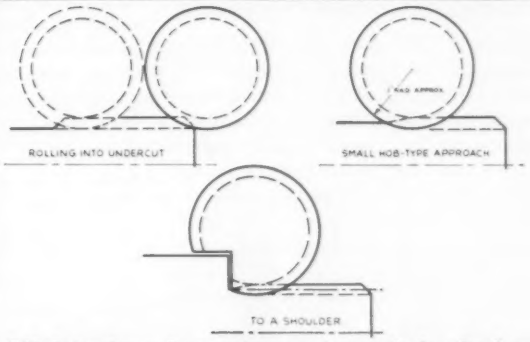
–for splines of any length

–with versatile lower cost tooling

–economical for shorter runs



Lower-cost tooling—*Cylindrical forming racks reciprocate in opposed directions while a part is fed in axially. Racks are indexable to several settings for long life and lower tool inventories. No regrind costs are involved with these throwaway forming inserts.*



All kinds of parts—*are inexpensively splined or serrated with this versatile new Roto-Flo method. Notched racks can form full-depth teeth within ¼ inch of a shoulder. Parts having the same diametral pitch can be rolled with the same rack.*

May we have the Roto-Flo field engineer in your area show you how this new method can make your parts better.

MICHIGAN TOOL Company

7171 E. McNICHOLS RD., DETROIT 12, MICH., U.S.A.
IN CANADA: COLONIAL TOOL CO. LTD.

New Parts and Materials

Use Yellow Card, page 19, to obtain more information

Flexible Gear Coupling

is flangeless, nonlubricated and lightweight unit

Nyflex flexible gear coupling weighs only 3½ lb and operates over a wide temperature range at speeds up to 5000 rpm. The lightweight, nonlubricated, flangeless unit has a one-piece nylon sleeve. Coupling is available in ten bore sizes from 7/16 to 1⅝ in. It takes nearly 5 deg more misalignment than standard gear couplings, absorbs both angular and parallel misalignment and end float with minimum of

backlash, and has run for more than 800 hr at total misalignment with no sign of wear. Unit is used on equipment such as portable motor-generating sets, motor-pump sets, and for other applications where size 1½ standard steel coupling is presently used. **Sier-Bath Gear & Pump Co. Inc.**, 9254 Hudson Blvd., North Bergen, N. J. D

Circle 674 on Page 19

Solid State Batteries

small units have high voltage ratings

Dynox batteries are available in four sizes: 0.14 cu in. with 95-v potential; 1.15 cu in. with 190-v potential; 1.57 cu in. with 380-v potential; 2.87 cu in. with 950-v potential. Batteries have applications in electronics systems where miniaturization and reliability in extreme environments are required, such as in power sources in missiles, avionics, alarm systems, instrumentation, and telemetering, as well as capacitor - charging applications. **Patterson, Moos Div., Universal Winding Co.**, 90-28 Van Wyck Expressway, Jamaica, N. Y. D

Circle 675 on Page 19

Straight Centrifugal Clutch

has only four moving parts

Two springs and two shoes are the only moving parts in this straight centrifugal clutch, making it suitable for applications on motors and small gasoline engines. It can be used to accelerate high inertia loads where smooth starting is essential, gives overload protection in situations where damaging overloads occur, and is suitable for pulsating loads. Unit provides free wheeling when prime mover is stopped, and furnishes dual drive from motor or engine. It is also useful for standby power applications. Clutch provides low-line voltage protection where transmission lines are inadequate, and permits use of smaller motors because maximum torque output is utilized for starting load. Available in capacities from 1 to 15 lb-ft at 1400 to 3600 rpm, clutch has 3, 3½, and 4¼-in. OD, with 7/16 to 1-in. bore. **Magneto Div., Fairbanks, Morse & Co.**, Beloit, Wis. K

Circle 676 on Page 19

Vinyl Wrinkle Finish

for metals is tough and scratch resistant

Vinyl wrinkle finish for metals is available by incorporating a compound known as Monomer MG-1 into vinyl plastisol, organosol, or solution coating formulations. Mixture is sprayed and then baked to provide a tough, scratch-resistant, pleasing finish. Applications include typewriters, electric equipment, office equipment, automobile heaters, and home air conditioners. **Union Carbide Chemicals Co., Div., Union Carbide Corp.**, 30 E. 42nd St., New York 17, N. Y. C

Circle 677 on Page 19

Clinch Nuts

self-swaging units permit fastening in thin metal

Swage Nuts are female-threaded fasteners which can be anchored firmly in metal sections as thin as 0.020 in. or as thick as 0.250 in. or more. Installation pressures in steel, brass, Monel, aluminum, and similar metals are as much as 50 per cent lower than with comparable nuts. The steel nuts can also be swaged into harder sheet metal up to Rockwell C 25. Nuts will hold 160,000-psi bolt loads without

Quietest Direct Drive Blower Motor

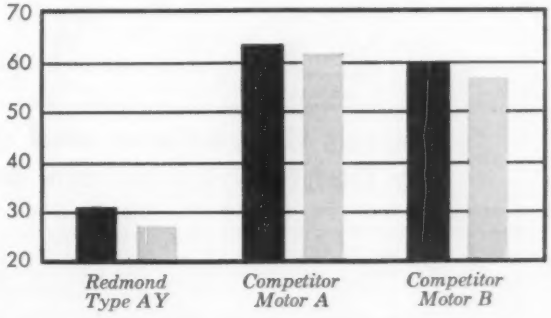
Place a mechanic's stethoscope on the end cap and you can easily hear the difference between the newly-designed Redmond Type AY and motors of conventional design. Try it on a Redmond 1/6 hp—the noise level is about that of a 1/35 hp motor of conventional design.

New Redmond Design Reduces Blower Vibration to One-Fifth that of units using Conventional Shaded-Pole Motors

Apply vibration tests and you will be quick to agree that here is the quietest direct-drive blower motor available. The AY Tri-Flux motor is designed and manufactured in every way to give years of trouble-free service and whisper-quiet operation. The positive oil system provides force-feed lubrication. Recirculating the oil assures maximum bearing life.

The graph shows vibration test results on the new Redmond design and two competitive motors. These tests were made with the best vibration testing equipment available. The solid black bar shows vibration on the motor end cap; the gray bar shows vibration on the blower housing. The graph is decibel readings on 120 cycles, since the 120 cycle frequency is the one that is the basic source of nearly all noise problems. Reduction of vibration is a logarithmic function—the reduction of vibration in the Redmond motor to 33 decibels reduces noise to only 1/5th that of conventional motors.

The new AY is ideal for a wide variety of applications requiring a whisper-quiet, economical, high-quality motor. Contact us at Owosso, Michigan, and we will have the Redmond sales engineer in your district call you at once.



CC Redmond COMPANY, INC.

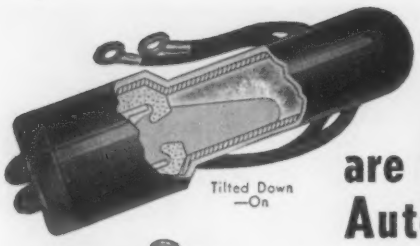
The Standard of Dependability

Subsidiary of CONTROLS COMPANY OF AMERICA

OWOSSO, MICHIGAN

REDMOND

Circle 493 on Page 19



DURAKOOL Tilt Switches are the Life of your Automatic Controls

MILLIONS OF CYCLES WITHOUT FALTERING

This steel-clad Durakool mercury tilt switch has unique construction features that deliver years of trouble-free performance on the most difficult assignments you can find. Operating under sealed-in, pressurized hydrogen gas, it takes 24 hours, fast cycling schedules in stride. 7 sizes, 1 to 65 amperes. Send for Bulletin D-49.

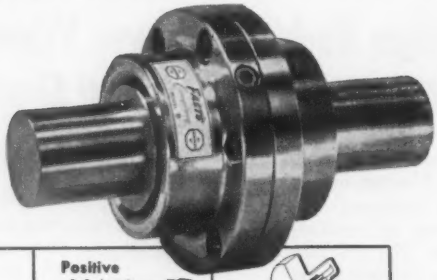
See telephone directory for local distributor, or write.

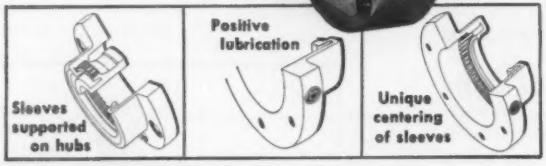
DURAKOOL, INC.
ELKHART, INDIANA, U.S.A.
200 WESTON RD., TORONTO 9, CANADA

Durakool ALL-STEEL MERCURY Switches

Circle 494 on Page 19

FAST'S Model B Coupling





reduces downtime and upkeep for light-to-medium drives!

Now you can profit from the durability and economy of famous Fast's couplings in a smaller and lower-cost version—available in 5 sizes for shafts ½" to 3⅛" in diameter.

The Model B coupling gives you the same features that have made Fast's the world's leading coupling for over 35 years. You get the same trouble-free performance, longer service life and lower maintenance costs. You also get prompt delivery because stocks are on hand to meet practically every need. Free engineering service is also available.

Write today for more details to KOPPERS COMPANY, INC., Fast's Coupling Dept., 3512 Scott Street, Baltimore 3, Maryland.

Engineered Products Sold with *Service*

KOPPERS

THE ORIGINAL *FAST'S Couplings*

failing. They are mounted flush on load side of nut and do not functionally deform, bend, or discolor sheet metal. Applications include electronic and electrical equipment, instrumentation, automotive, aircraft and machinery subassemblies, home appliances, and office equipment. Nuts are available in screw diameter sizes No. 2 through ½ in., and threads are Class 2B. **Standard Pressed Steel Co.**, Jenkintown, Pa. C

Circle 678 on Page 19

Electronic Timer

plug-in delay unit is completely self-contained

Electronic time-delay relay is completely self-contained in a steel can measuring 2 x 2¼ x 3⅛ in. high. Octal radio-type plug is furnished for mounting and wiring connections. Timer employs a circuit which controls breakdown of gas

tubes and provides timing delays from 0.003 to 300 sec, unaffected by variations in line voltage. Unit requires no warmup and consumes less than 2 w. Timer recycles instantly, and any number of timers can be connected together to provide a sequence of controlled intervals. **G. C. Wilson & Co.**, Huntington, W. Va. F

Circle 679 on Page 19

Flow-Control Valve

is pressure and temperature compensated

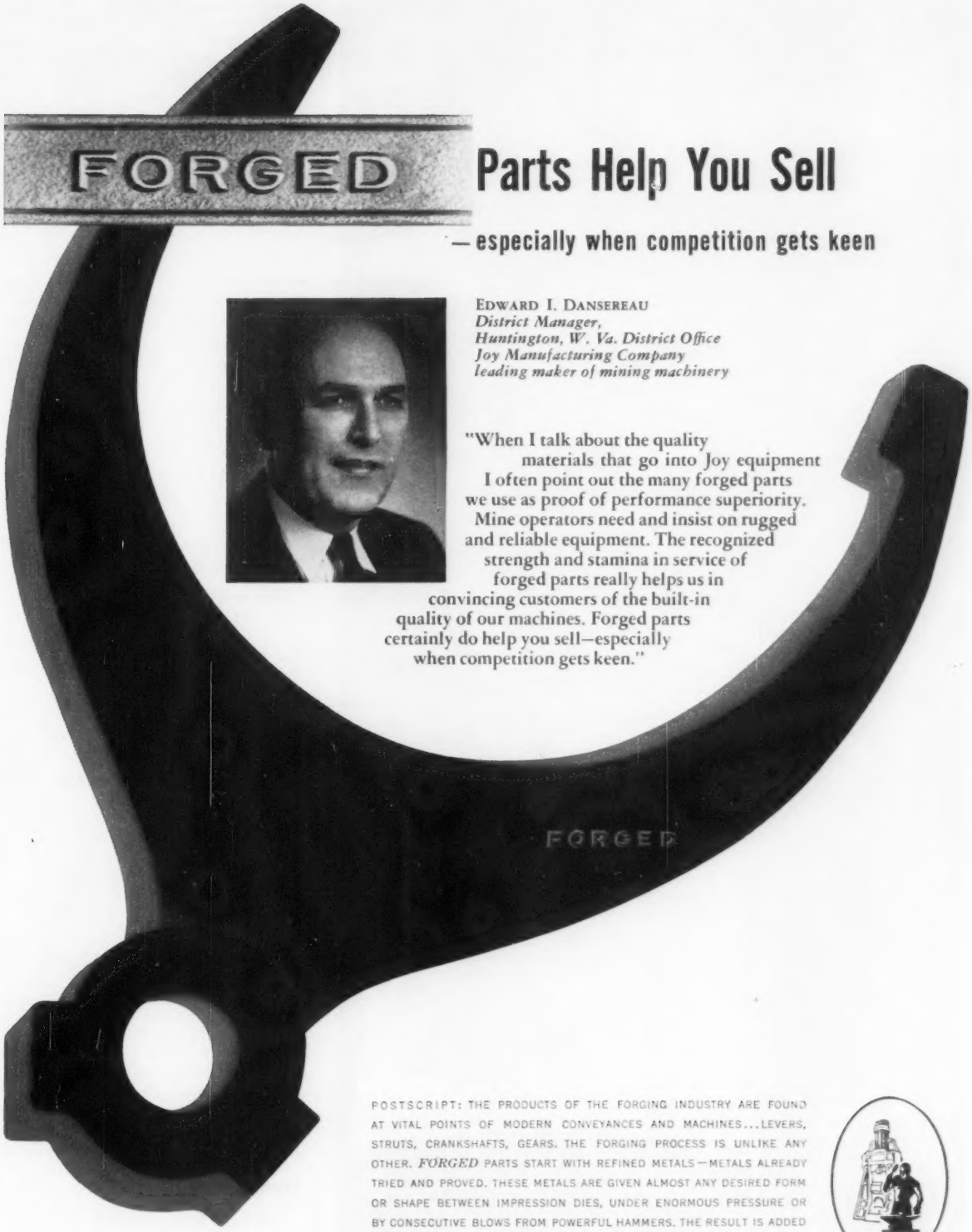
New ¼-in. flow-control valve is interchangeable with any of 12 models in 5 to 1000 cu in. per min flow range. Unit is both pressure and temperature compensated. Temperature - sensing mechanism automatically varies orifice size to compensate for concurrent changes in fluid viscosity, reducing average flow variations due to temperature

FORGED Parts Help You Sell

—especially when competition gets keen

EDWARD I. DANSEREAU
District Manager,
Huntington, W. Va. District Office
Joy Manufacturing Company
leading maker of mining machinery

"When I talk about the quality materials that go into Joy equipment I often point out the many forged parts we use as proof of performance superiority. Mine operators need and insist on rugged and reliable equipment. The recognized strength and stamina in service of forged parts really helps us in convincing customers of the built-in quality of our machines. Forged parts certainly do help you sell—especially when competition gets keen."



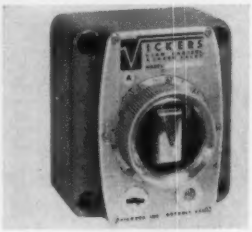
POSTSCRIPT: THE PRODUCTS OF THE FORGING INDUSTRY ARE FOUND AT VITAL POINTS OF MODERN CONVEYANCES AND MACHINES...LEVERS, STRUTS, CRANKSHAFTS, GEARS. THE FORGING PROCESS IS UNLIKE ANY OTHER. *FORGED* PARTS START WITH REFINED METALS—METALS ALREADY TRIED AND PROVED. THESE METALS ARE GIVEN ALMOST ANY DESIRED FORM OR SHAPE BETWEEN IMPRESSION DIES, UNDER ENORMOUS PRESSURE OR BY CONSECUTIVE BLOWS FROM POWERFUL HAMMERS. THE RESULT IS ADDED STRENGTH AND TOUGHNESS...WHICH PERMITS WEIGHT-SAVING DESIGNS, CUTS SERVICE COSTS, HELPS PROVIDE SAFETY IN A HIGH-SPEED WORLD.

DROP FORGING ASSOCIATION • 55 Public Square • Cleveland 13, Ohio

COMPOSED OF THE INDEPENDENT COMPANIES PRODUCING THE MAJOR SHARE OF COMMERCIAL FORGINGS IN THE UNITED STATES & CANADA

Circle 496 on Page 19

WHAT'S YOUR CLAMPING PROBLEM?
WITTEK
HAS THE ANSWER
Here is a selection from among the many different types and sizes of hose clamps designed and manufactured by WITTEK. Whatever the hose connecting problem, it's a safe bet that WITTEK (leader for over a quarter century) has the exact type and size clamp to do the job right! Let WITTEK help solve your clamping problems. Write today.
5187
WITTEK MANUFACTURING COMPANY
4349 West 24th Place • Chicago 23, Illinois



changes by 75 per cent. Single, adjustable throttle permits fine flow-rate adjustment throughout specified range. Integral check valve provides for reverse free flow. Maximum reverse flow is rated at 1400 cu in. per min. Setscrew prevents inadvertent throttle movement, and cover over the screw can be locked in place. **Vickers Inc., Div., Sperry-Rand Corp.,** 172 E. Aurora St., Waterbury 20, Conn. B

Circle 680 on Page 19

Miniature Brake

has minimum torque of 40 oz-in.

Industrial B-125 miniature electromagnetic brake is completely self-contained, weighs only 6 oz, and has servo-mounting diameter of 1.125 in. It can also be face mounted. Minimum torque is 40 oz-in. Unit provides quick response, zero

backlash, requires no slip rings, and is available with output shaft at either or both ends. **Autotronics Inc.,** Eng. Dept. 17, Box 208, Florissant, Mo. I

Circle 681 on Page 19

Transmission Unit

Class 3 unit provides instantaneous speed changing

Multipurpose, Class 3 commercial-type transmission unit, containing five gear sections, is designed for speed, variability, and smooth operation. Instantaneous speed changing requires no gear change. Unit has low-inertia gear train, requires

Circle 497 on Page 19

T-J spacemaker cylinder

Quality Engineered

to give quality results

with Extras . . . at No Extra Cost!

You get more—much more—when you specify and use any of T-J's complete line of Spacemaker cylinders. The Spacemaker is engineered to give you better, more accurate, and longer service—offers, exclusively, many extras . . . that are STANDARD, AT NO EXTRA COST!

Designed to eliminate tie-rods, providing greater strength . . . saves space . . . reduces manhours and costs in all push-pull-lift operations. IMMEDIATE SHIPMENT in a wide range of styles and capacities, with 64,000 combinations. Write for Bulletin SM 155-3 with complete engineering details. The Tomkins-Johnson Co., Jackson, Mich.

T-J TOMKINS-JOHNSON
RIVETORS, AIR AND HYDRAULIC CYLINDERS, CUTTERS, CLINCHORS

METAL PISTON ROD SCRAPER . . . Standard at No Extra Cost!

NEW "SUPER" CUSHION FOR AIR . . . Standard at No Extra Cost!

CHROME PLATED CYLINDER BORES AND PISTON RODS . . . Standard at No Extra Cost!

ONE PIECE PISTON . . . Standard at No Extra Cost!

NEW "SELF-ALIGNING" MASTER CUSHION FOR HYDRAULIC USE . . . Standard at No Extra Cost!

NO TIE-RODS TO STRETCH . . . Standard at No Extra Cost!

STREAMLINED DESIGN . . . Oil Pressure to 750 P.S.I.—air to 200 P.S.I. Standard at No Extra Cost!

FORGED SOLID STEEL HEADS . . . Standard at No Extra Cost!

Circle 498 on Page 19

STANPAT SOLVES THE GHOSTING PROBLEM

NEW resin-base STANPAT ELIMINATES GHOSTING, offers better adhesion qualities on specific drafting papers!

THE PROBLEM
Some of our longtime customers first called our attention to the "ghosting" problem. Certain tracing papers contain an oil which could be leached out by the STANPAT adhesive (green back) causing a ghost.

THE SOLUTION
A new STANPAT was developed (red back), utilizing a resin base which did not disturb the oils and eliminates the ghost. However, for many specific drafting papers where there is no ghosting problem, the original (green back) STANPAT is still preferred.

WHICH ONE IS BEST FOR YOU?
Send samples of your drawing paper and we will help you specify. Remember, STANPAT is the remarkable tri-acetate pre-printed with your standard and repetitive blueprint items—designed to save you hundreds of hours of expensive drafting time.

SO SIMPLE TO USE

1. PEEL the tri-acetate adhesive from its backing.

2. PLACE the tri-acetate in position on the tracing.

3. PRESS into position, will not wrinkle or come off.

STANPAT CO.
WHITESTONE 67, N.Y., Dept. 74
Phone: Flushing 9-1693-1611

STANPAT CO. Whitestone 57, N. Y. U.S.A.

☐ Enclosed are samples of the drafting paper(s) I use (identify manufacturer). Please specify whether Rubber Base or Resin Base STANPAT is most compatible with these samples.

☐ Send literature and samples of STANPAT.

☐ Please quote price on our enclosed sketches which we are considering to have pre-printed.

NAME_____

FIRM_____

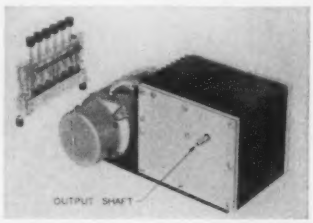
ADDRESS_____

CITY_____

ZONE____ STATE_____

Circle 499 on Page 19

no lubrication, and weighs 6½ lb. Gear ratio with optional low-speed motor, in 12 steps, is 2560:1. With transmission-drive motor, it covers ratio of 128:1 in eight steps. Another 256:1 ratio, in 12 steps, is obtained with use of optional dual-speed transmission motor. Output torque is 128 oz-in., maximum breakaway torque is 6 oz-in., and top running



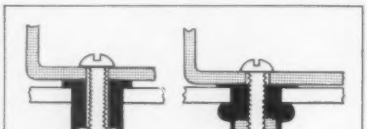
torque is 4 oz-in. Pitch of aluminum and nylon helical gears is 48, with pressure angle of 14½ degrees. Control is by optional pushbutton switch. **Hathaway Instrument Div., Hamilton Watch Co.**, 5800 E. Jewell Ave., Denver 22, Colo. K

Circle 682 on Page 19

Blind Fastener

antivibration unit is available in three new sizes

Well-Nut neoprene bushing with bonded threaded hex brass nut is now furnished in three new sizes with plug lengths of 0.620, 0.437, and 0.642 in. and threads of 10/32, 10/24, and ¼-20 respectively. New sizes have thicker, wider flanges than previous units. As torque is applied to screw, brass nut draws neoprene against back of material,



providing firm hold. **Rockwell Products Corp.**, 146 Central Ave., Newark 3, N. J. D

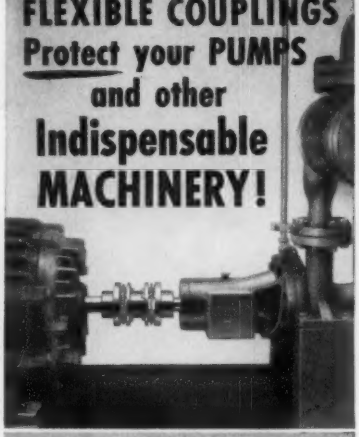
Circle 683 on Page 19

Quick-Connect Switch

tiny unit has high electrical rating

V3-1-D8 small quick-connect switch has electrical rating of 10 amp, 125 or 250 v ac; ½ amp, 125 v dc; ¼ amp, 250 v dc. Lead receptacles for

THOMAS FLEXIBLE COUPLINGS Protect your PUMPS and other Indispensable MACHINERY!



NO LUBRICATION
NO MAINTENANCE
NO WEARING PARTS

Future maintenance costs and shutdowns are eliminated when you install Thomas Flexible Couplings. These all-metal couplings are open for inspection while running.
They will protect your equipment and extend the life of your machines.
Properly installed and operated within rated conditions, Thomas Flexible Couplings should last a lifetime.

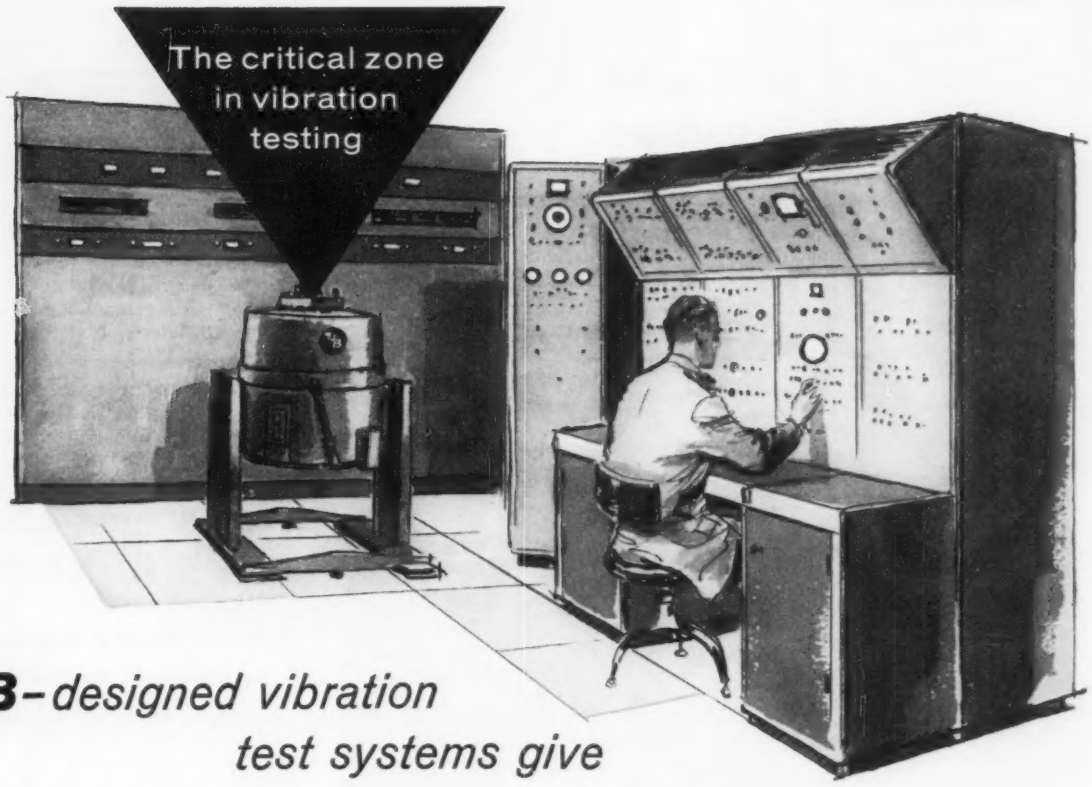
UNDER LOAD and MISALIGNMENT ONLY THOMAS FLEXIBLE COUPLINGS OFFER ALL THESE ADVANTAGES:

- Freedom from Backlash
- Torsional Rigidity
- Free End Float
- Smooth Continuous Drive with Constant Rotational Velocity
- Visual Inspection While in Operation
- Original Balance for Life
- No Lubrication
- No Wearing Parts
- No Maintenance

Write for Engineering Catalog

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.

Circle 500 on Page 19



MB–designed vibration test systems give

high performance table motion

It's *System Performance* that counts most in vibration testing.

Whole purpose of a vibration test system, large or little, is to subject specimens to *motions* that simulate service conditions as closely as possible. Such motion gives you *reliable* information on vibratory response and performance of structures, products, components. It helps reduce risk of malfunction or failures in the field.

But many factors contribute to this motion. Among them: force output and characteristics of the exciter; ample and undistorted power supply to meet all shaker-plus-specimen load relationships; meticulous matching of components in the entire system from input signal to output at the shaker table.

INTEGRATED SYSTEM OFFERS OPTIMUM RESULTS

As the manufacturer of *complete* systems, MB intimately knows the operational needs of shaker, builds amplifiers and controls around those needs. Each MB system is integrated toward the highly desired end result . . . *delivering optimum performance at the shaker table* for present and future needs.

The largest field service organization in vibration testing is ready to help you achieve that result. For latest information, call on MB.

HIGH FORCE HIGH PERFORMANCE SYSTEM

Shown above is a typical MB test system. It includes a Model C70 7000 pound force vibration exciter fit for environmental testing chambers.

The MB T996 amplifier is rated at 50KVA output and can handle the most adverse reactive shaker loads for broad-band sine wave and random motion testing. The T68MC control console is easy to use, also provides automatically cycled testing. The T88 console expands system for complex motion work.

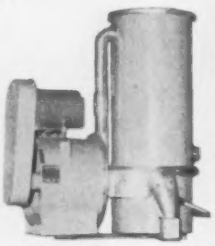
Send for Bulletin 470 which gives detailed specifications on the high performance available from this system; and from others to 25,000 pounds force.

largest producer of complete systems for vibration testing

MB manufacturing company 1056 State Street New Haven 11, Conn.

A Division of Textron Inc.

Circle 501 on Page 19



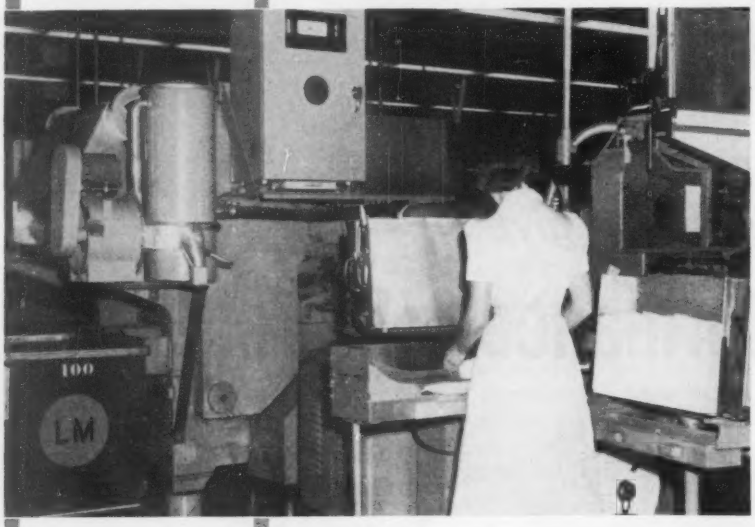
at L & M another

DESIGN PROBLEM

solved . . . with a

SPENCER

vacuum unit



Two Catalogs to Aid the Designer

"132 UNUSUAL USES OF SPENCER VACUUM"
Bulletin 144 illustrates and describes how Spencer Vacuum is used in industries from A to Z.

"TURBO DATA BOOK"
Supplies application data on Spencer Blowers. Request Bulletin 107-C.

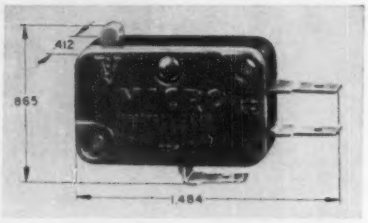
The designer's problem here was: find a means of picking up the "shorts"—short pieces of tobacco which hang loosely on the end of a cigarette before the filter tip is applied.

Incorporation of a SPENCER vacuum unit, connected adjacent to the main cigarette drum, proved the answer.

Perhaps vacuum can solve *your* design problem. Why not check with SPENCER, producers of a complete line of vacuum units—standard or specially adapted to meet your particular needs.

STANDARD CAPACITIES of Spencer Vacuum Producers
2 through 400 H.P.
Up to 12" Mercury Vacuum
Volumes up to 17,000 C.F.M.

The SPENCER TURBINE COMPANY
HARTFORD 6, CONNECTICUT



the switch can be attached quickly. Contact arrangement is single pole, double throw, and switch can be wired normally open or normally closed. Variety of roller and lever-type auxiliary actuators can be attached for applications where operating direction is not in line with plunger motion. **Micro Switch Div., Minneapolis-Honeywell Regulator Co.**, Freeport, Ill. K

Circle 684 on Page 19

Two-Component Adhesives

for bonding treated Teflon

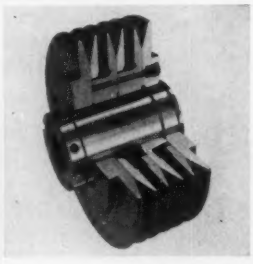
Two new adhesives are available for cementing bondable treated Teflon to itself or to other materials. Ray-Bond R-86009 is recommended for applications where some flexibility in bond is required. It has good resistance to water and most chemicals. Ray-Bond R-86044 has excellent resistance to acids (except acetic) and various other chemicals, as well as water. Both materials are two-component systems which bond etched Teflon to wood, steel, glass, aluminum, ceramics, plastics, or any other material that bonds with an adhesive. **Adhesives Dept., Raybestos-Manhattan Inc.**, Bridgeport 2, Conn. B

Circle 685 on Page 19

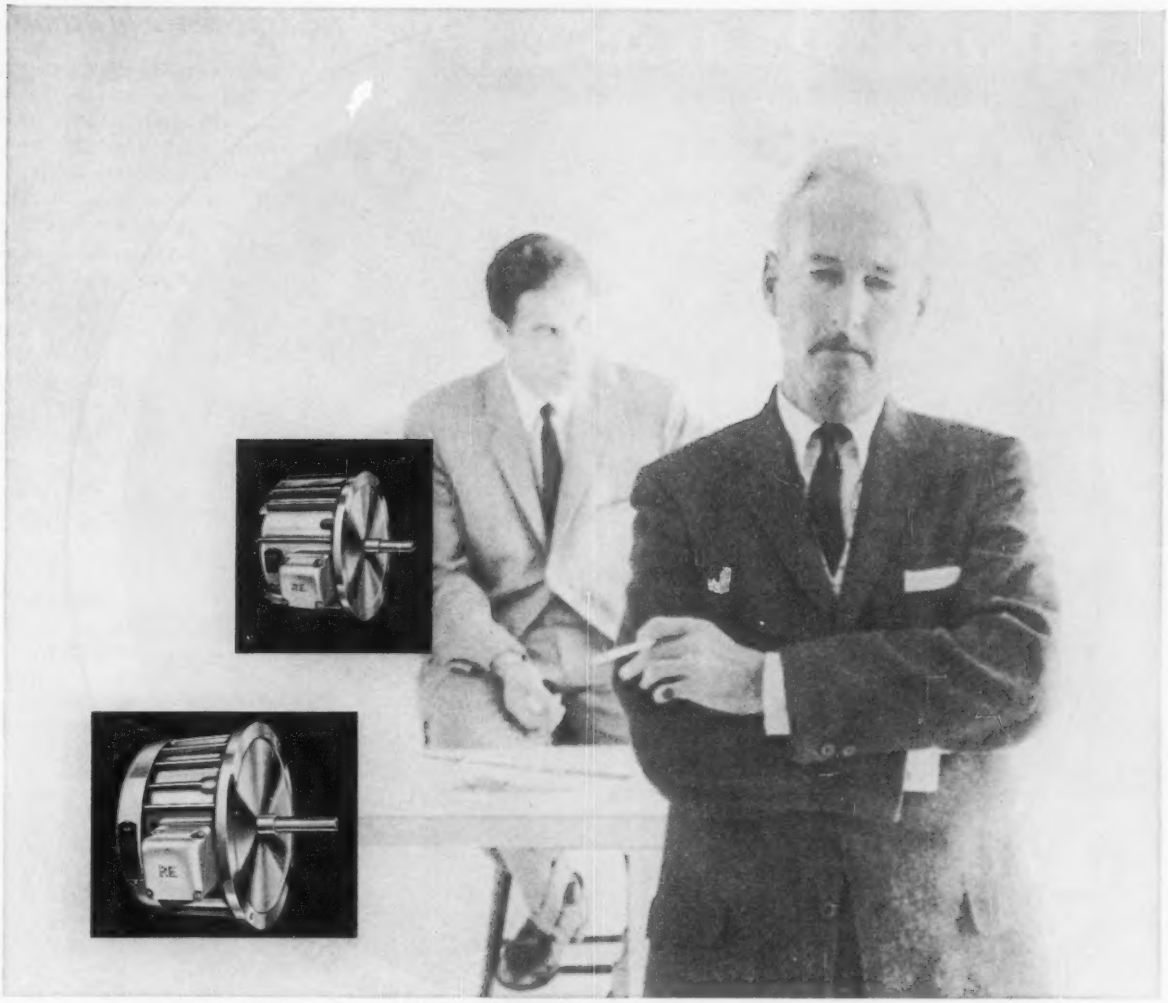
Adjustable-Speed Sheave

for A, B, and C-section belts

Adjustex stationary-control, adjustable-speed sheave incorporates pitch diameter adjustment, made



Circle 502 on Page 19



WHY DO LEADING MACHINE TOOL DESIGNERS SPECIFY REULAND PRECISION **MACHINE TOOL MOTORS?**

The answer is that these men *know* Reuland Precision Machine Tool Motors are made specially, and only, for machine tool use. Not just another motor that can be "adapted to fit," but a completely new concept that finally achieves the vibrationless operating characteristics so vital to precision machine tool operation.

Dynamic Balancing at our factory tunes every motor to the jewel-like perfection of a fine watch. *Bearings On Each Side Of Rotor* hold it solidly in dynamic position ...lock this true balance in forever once it is achieved. *Radial Air Gap Design* permits the use of a light, narrow, low inertia rotor which, in turn, assures smooth starts and quick stops. The motor's overall length is also reduced to give it a thinner "wafer" effect. *Fin-Type Cast Aluminum Alloy Frames* dissipate heat approximately three times faster than cast iron. *Smooth Castings and Pleasing Lines* are the exterior quality trademarks. All surfaces are specially processed for smoothness and are given a fine, baked enamel finish. This fine-quality finish, together with the motor's naturally pleasing lines, assures a harmonious blend with the lines of every machine tool on which it is mounted. (When desired, the motor's frame size can be varied to fit an *exact* contour of your machine.) *All Heavy Duty Ratings*... ½ h.p. through 10 h.p....are available in totally enclosed fan-cooled and totally enclosed non-ventilated types...either continuous or intermittent duty.

SEE WHAT REULAND CAN DO FOR YOU...by *actually testing* a Reuland Machine Tool Motor on your machine. So sure are we that you will like what you see, we are offering to engineer a demonstration unit to your equipment without the slightest obligation. Just write us.

Our new 8-page brochure "MODERN POWER FOR MODERN-DAY PRODUCTS" will be helpful in your work. Sent free on request.

MODERN POWER FOR MODERN-DAY PRODUCTS

REULAND MOTORS

REULAND ELECTRIC COMPANY
Western Division: Alhambra, Calif.
Eastern Division: Howell, Michigan
Distributors in all principal cities

Tubexperience in action

Superior weighs a wall to "zero in" on your tubing tolerance

Weight control gives precise check of tubing dimensions to help your product performance

*These delicately balanced scales weigh a length of tubing accurately to within 1/1000 lb. The relationship of weight to length and to OD tells us how closely the tubing wall or ID conforms to specifications. This fast, precise method of checking average wall or ID enables us to provide you with a tubing order whose overall uniformity is unusually high. In certain applications, tubing produced by this weight control method can materially improve performance for you. It results in minimizing variations in your product caused by tubing whose average wall or ID varies too widely from the required design mean.

This is but one of many modern tools and techniques that help improve the already high quality of Superior small tubing.

Our premium quality small tubing is offered in a range of analyses (over 120) unsurpassed in the industry. Included are stainless, carbon and alloy steels, nickel and nickel alloys, beryllium-copper, titanium and zirconium—and 16 different Super Alloys. Our range of sizes and shapes is equally extensive.

Special services include statistical quality control, pilot and test lot sampling and melting, dye penetrant inspection, ultrasonic and hot tensile testing, eddy current and X-ray inspection, specification services—and field specialists who will call on you at your request.

For handy reference in your files, get a copy of Bulletin 40, "Selection and Application Guide for Superior Tubing." Write Superior Tube Company, 2010 Germantown Ave., Norristown, Pa.

Superior Tube

The big name in small tubing

NORRISTOWN, PA.

All analyses .010 in. to ⅝ in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Company • 5710 Smithway St., Los Angeles 22, Calif. • RAymond 3-1331

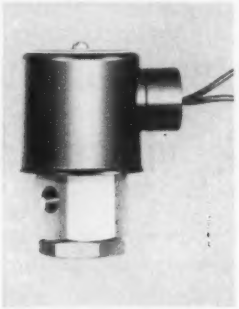
through a single adjusting screw and a hollow lock screw. Relative position between stationary and movable discs is positively maintained at all pitch diameters without disc to main sleeve setscrews. Sheave is available for A, B, and C-section belts in two, three (shown), and four-groove construction. New pitch diameter for C-section belts, 7.5/9.7 in., is available for high speed and wide speed range applications. Design capacities to 75 hp are covered by 33 sizes. **Allis-Chalmers Mfg. Co.**, Milwaukee 1, Wis. K

Circle 686 on Page 19

Small Solenoid Valve

is only 3¼ in. high

New solenoid valve, designated type TT, is a single-seated, angle-type unit machined from brass bar stock with stainless-steel plunger and point assembly. Direct lift operation permits use in applications where a



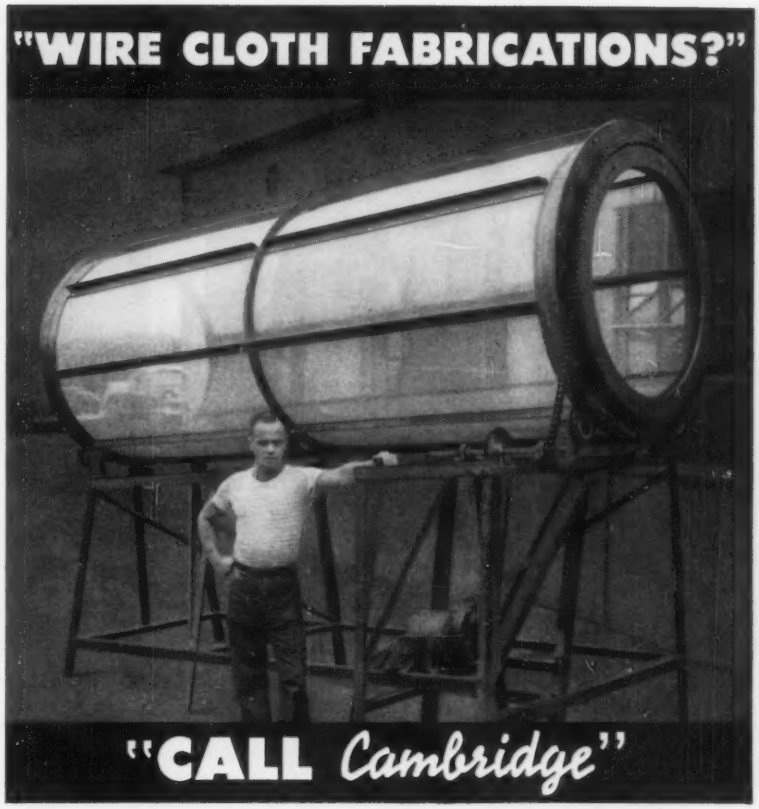
wide range of pressures is coupled with relatively little flow. Only 3¼ in. high, valve is used for air, gases, water, oil, steam, and other media not harmful to brass. Pressure range is from 0 to 400 psi, and pipe sizes are ⅛ and ¼ in. **Atkomatic Valve Co. Inc.**, 545 W. Abbott St., Indianapolis 25, Ind. J

Circle 687 on Page 19

Miniature Connectors

permit reception of weak, low-level signals

TM Series of thread-coupled, miniature, lightweight coaxial connectors eliminate extraneous electrical noise. Mechanical features include beryllium-copper shield and female contacts, gold-plated contacts, and thread coupling for positive locking. Connectors are matched electrically for 50-ohm impedance, and



"You tell us what you need, and we'll have it for you fast— whatever the size or shape"

Roland's right, too. Here at Cambridge he's part of a team that has produced everything from thimble-sized strainers to king-sized dewatering screens, often well ahead of schedule. Whatever your requirements, you're assured of quality workmanship and prompt service when you call Cambridge. And, we'll work from your specifications or draw up prints for your approval.

TO MEET YOUR BULK WIRE CLOTH NEEDS, we have a wide variety of specifications from the finest to the coarsest mesh—in any metal or alloy—in the most frequently used specifications ready for immediate shipment. Individual loom operation and careful inspection just before shipment assures accurate mesh count and uniform mesh size.

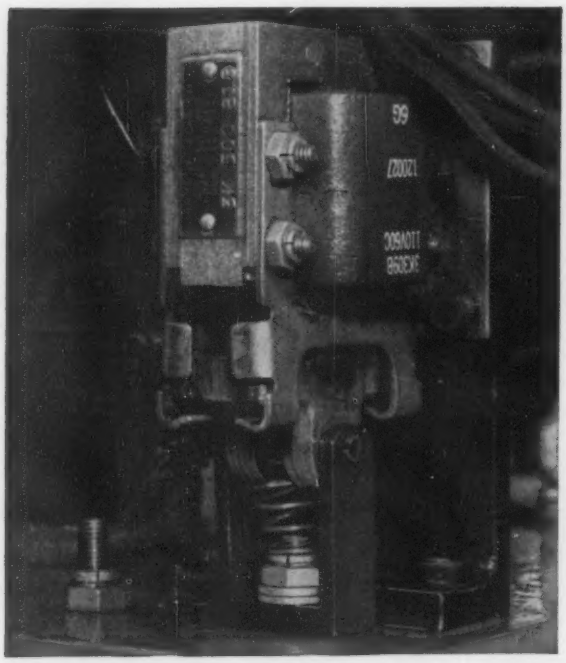
Let us quote on your next order for wire cloth. Call your Cambridge Field Engineer listed in the telephone book under "Wire Cloth". Or write direct for FREE 94-PAGE CATALOG and stock list giving the full range of wire cloth available. Describes fabrication facilities and gives useful metallurgical data.

The Cambridge Wire Cloth Company

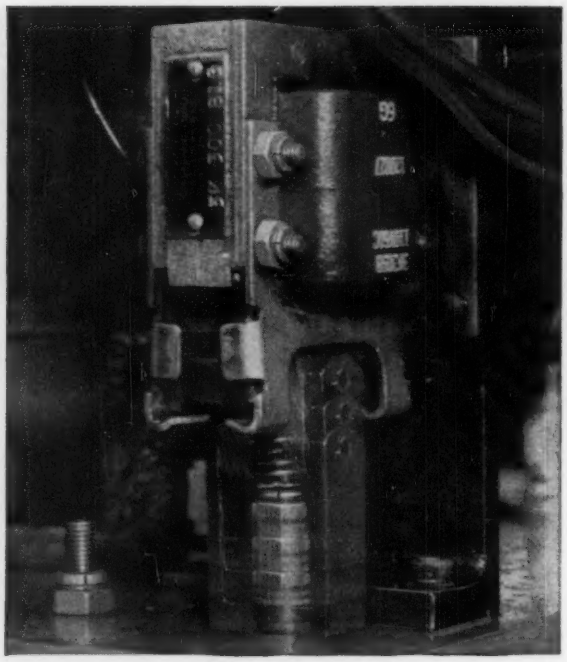
WIRE CLOTH | METAL-MESH CONVEYOR BELTS | WIRE CLOTH FABRICATIONS

DEPARTMENT N, CAMBRIDGE 12, MARYLAND

OFFICES IN PRINCIPAL INDUSTRIAL CITIES

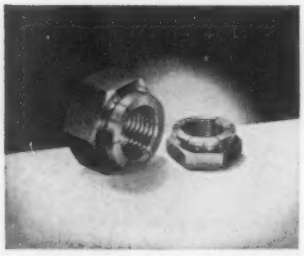


Both regular and thin height FLEXLOC nuts are used to fasten this solenoid valve assembly on a 15,000-lb.-capacity fatigue testing machine. Valve monitors the oil supply to a control cylinder which maintains a constant load on the test specimen.



Stroboscopic photo shows action of solenoid in opening oil supply valve. Unit is capable of speeds up to 60 cycles/sec., chatters hard whenever a test specimen breaks. Despite impact and vibration, the FLEXLOC nuts never require retightening.

FLEXLOC self-locking nuts give your products greater reliability under impact, shock, vibration



Repeated shock, pounding of heavy machinery, high-speed oscillation—nothing will loosen a FLEXLOC self-locking nut. FLEXLOCs help give your assemblies the increased reliability demanded by today's higher operating temperatures, faster speeds, and greater dynamic stresses.

FLEXLOCs are available in either regular height or thin height configurations, the latter being designed for applications where space and weight savings are vital. Both are 1-piece, self-locking units requiring no auxiliary locking elements—no lockwashers, jam nuts or cotter pins. There is nothing extra to put together, come apart or get lost . . . and no nonmetallic inserts to waste head space or weaken the structure of the nut. With a FLEXLOC, every thread, including those in the locking section, carries its full share of the tensile load.

Because they require no separate locking devices, FLEXLOC self-locking nuts facilitate design and specification, simplify inventory and handling, reduce assembly time and costs. They also save on maintenance, because they are readily removed and can be reused many times with no effect on the reliability of their locking action.

Your authorized SPS distributor carries FLEXLOC self-locking nuts—regular and thin height—in all standard sizes, materials and finishes. Flexloc Locknut Division, STANDARD PRESSED STEEL CO., Jenkintown 18, Pa.

HIGH RELIABILITY

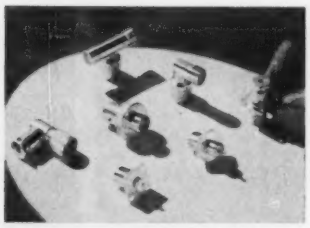
SPS research is continually developing fasteners with higher standards of predictable performance. By installing SPS high-reliability fasteners in your assemblies, you increase overall product reliability.

For more information on the full meaning of reliability, write for a copy of the new SPS booklet "High Reliability."

We also manufacture precision titanium fasteners / write for free booklet

SPS Jenkintown • Pennsylvania

Standard Pressed Steel Co. • The Cleveland Cap Screw Co. • Columbia Steel Equipment Co. • National Machine Products Co. • Nutt-Shel Co. • SPS Western • Standco Canada Ltd. • Unbrako Socket Screw Co., Ltd.



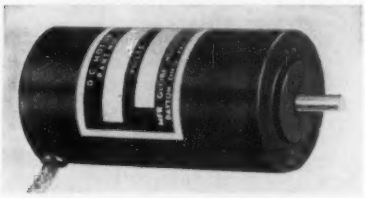
some designs are available for 70 and 93-ohm cables. Units withstand 500 v rms, and are for use in temperatures from −65 to 260 F. For use in precision equipment, they incorporate Teflon insulators and dielectrics. **General RF Fittings Inc.**, 702 Beacon St., Boston, Mass. B

Circle 688 on Page 19

Permanent-Magnet Motors

1½-in. diam units have high rated outputs

Type BD and BL 1½-in. diam permanent-magnet motors have rated outputs of 1/45 and 1/30 hp respectively at 10,000 rpm continuous-duty cycle. Various armature windings are available for different voltages to provide for particular applications. Speed governors, gear trains, and brakes can also be adapted to the motors. Units meet aircraft and missile standards requirements. BD motor measures 1½ x 2 9/16 in., and BL unit is 1½



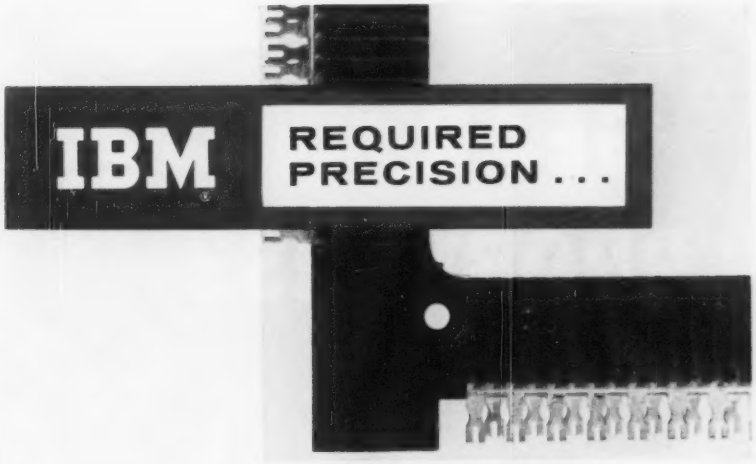
x 2 15/16 in. in size. **Globe Industries Inc.**, 1784 Stanley Ave., Dayton 4, Ohio. G

Circle 689 on Page 19

Subminiature Thermocouples

in metal sheaths provide fast response

Metal clad and ceramic-insulated from high-temperature, subminiature thermocouples resist corrosion, abrasion, and erosion, and are readily formed. Diameters range from 0.020 to 0.040 in. OD, two-wire. Shown are two units with OD of 0.020 and 0.032 in. They are available in several sheath materials and

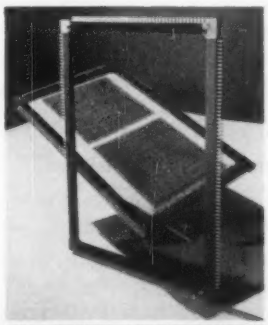


and got it from CONSOLIDATED

This 12" x 15" phenolic "Memory Frame" for IBM was plunger molded in one piece with 440 wire terminal inserts. Later, strung with copper wire containing a series of 8,000 ferrite magnetic cores, these frames are stacked one atop the other and wired together in conjunction with other components to give IBM's 705 Data Processing System a "memory" capacity of 40,000 characters.

Dimensionally stable frames that would withstand dip soldering at extra high temperatures were a necessity. They could not bow or crack, nor could there be more than minimum after-shrinkage or expansion once assembly was completed.

For more than 80 years we have been filling exacting plastics orders for the nation's blue chip companies. Before you discard any design you feel can't be molded in a plastic, call Consolidated.



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"Your Blueprint in Plastics" Since 1874

CONSOLIDATED MOLDED PRODUCTS CORPORATION

335 Cherry St., Scranton 2, Penna.

Circle 507 on Page 19

GEAR PROBLEMS?

—check with FAIRFIELD!

GEAR PERFORMANCE to match the ever-increasing power and speed of modern machines is a Fairfield specialty. This is possible because Fairfield has long held a position of leadership in utilizing the most advanced methods, equipment, and techniques for producing better gears. By keeping apace with modern engineering trends, Fairfield renders an invaluable service to many of the nation's leading machinery builders.

If you have a gear problem, check with Fairfield. Our engineers are well-qualified to give you expert recommendations. CALL OR WRITE.

SPUR GEARS—Straight, helical, and internal. Sizes from 16 pitch, 1½" dia., to 1½ pitch, 36" dia.

HERRINGBONE—(Fellows Type). Sizes from 1½" to 15"

SPIRAL BEVEL—Sizes from 16 pitch, 1½" dia., to 1½ pitch, 28" dia.

STRAIGHT BEVEL—Sizes from 16 pitch, 1½" dia., to 1½ pitch, 28" dia.

HYPOID—Sizes from 1½" to 28" dia.

ZEROL—Sizes from 16 pitch, 1½" dia., to 1½ pitch, 21" dia.

WORMS AND WORM GEARS—Worms to 7" dia. Worm gears to 36" dia.

SPLINED SHAFTS—Lengths to 72".

DIFFERENTIALS—3,000 to 500,000 inch pounds capacity.

Note: All of the sizes above are approximate.

FAIRFIELD MANUFACTURING CO.

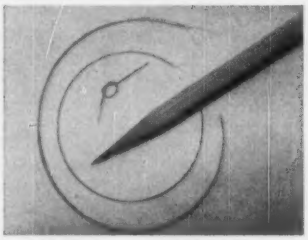
2307 S. Concord Rd. Lafayette, Indiana

TELEPHONE: 2-7353

Ask for interesting, illustrated bulletin.

Gears and Differentials *Made to Order for:*

TRACTORS • HEAVY DUTY TRUCKS • AGRICULTURAL MACHINERY • POWER SHOVELS AND CRANES
MINING MACHINES • ROAD GRADERS • BUSES • STREET SWEEPERS • INDUSTRIAL LIFT TRUCKS



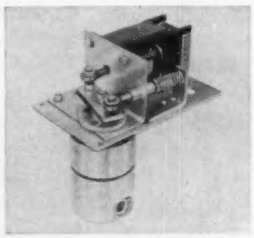
most conductor combinations. Other materials are available on special order. **Pyro-Electric Inc.**, Dept. 26, P.O. Box 232, Barrington, Ill. J

Circle 690 on Page 19

Solenoid Valves

for 10,000-psi liquid or gas pressure

Shut-off and four-way valves in ¼, ⅜, and ½-in. port sizes are rated for 10,000 psi liquid or gases. Designed for a burst pressure of 30,000 psi, they withstand surges of up to 15,000 psi without damage to sealing qualities. Solenoids are available for 115, 230, and 460-v ac operation. Leakproof Shear-Seal design provides long maintenance-free service. Seals lap themselves to a more perfect fit with each valve operation. Pressure is confined to



flow passages, eliminating external shaft leakage. **Barksdale Valves**, 5125 Alcoa Ave., Los Angeles 58, Calif. L

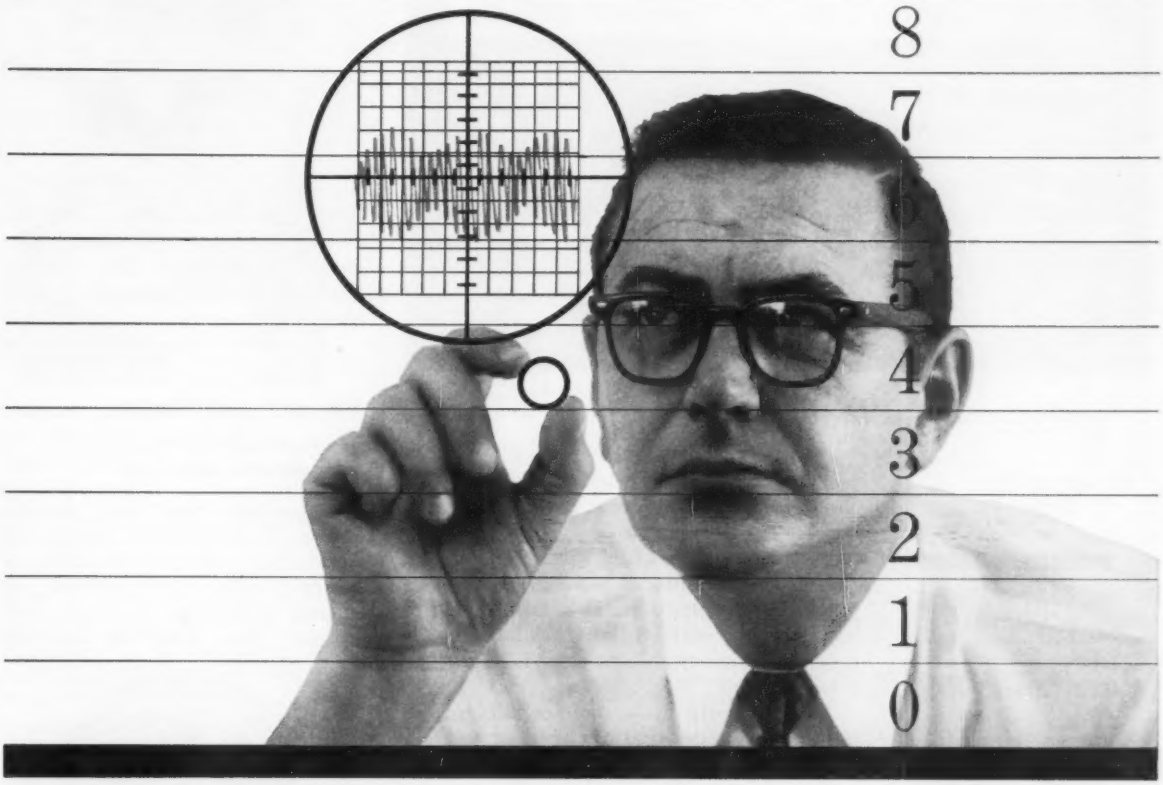
Circle 691 on Page 19

Clutches and Brakes

with magnetic flux acting directly on disc

Series 9000 Maxitorq electric clutches and brakes range in size from ¾ to 3½ in. bore and have up to 2400 lb-ft of torque (static). Units are held in engaged position by action of magnetic flux passing through buttress plate, disc assembly, and end plate. Upon release, disc separators separate discs individually and break up residual mag-

NO ROOM FOR ERROR...AT THE COUNTDOWN...



Linear accelerometer needs no heater jacket–reliability and accuracy from

−65°F TO +200°F

When critical missile and aircraft testing demands an accelerometer of accurate, reliable operation over wide temperature range, specify Statham Model A501.

The remarkable design feature of the Model A501 lies in the use of gas damping. This method of damping permits the operation of the unit over a −65°F to +200°F range without use of a heater jacket. It produces–flat up to 500 cycles per second–reliable signals of rapidly changing acceleration.

Statham instruments are specified by leading manufacturers and government facilities...wherever accuracy, reliability, and superiority are required.

For detailed technical data to answer *your* application needs, write for Bulletin Number A501TC.

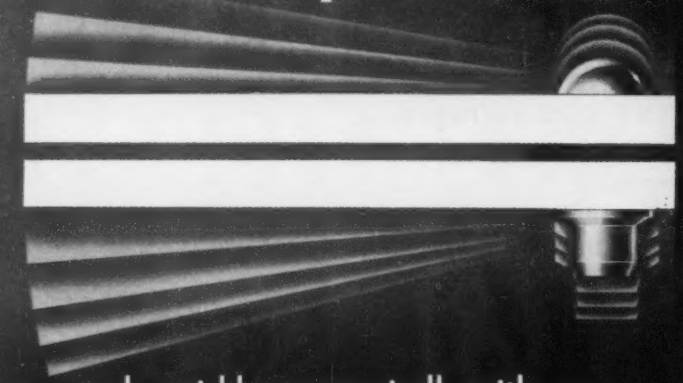
Range:	±5 to ±50 g
Excitation:	5 volts DC or AC (rms)
Output:	±20 millivolts
Non-linearity and Hysteresis:	Not more than ±1% full scale
Weight:	6½ ounces

Statham

accuracy / integrity / reliability

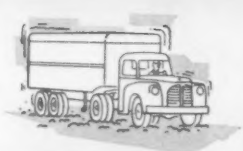
Statham Instruments, Inc. 12401 West Olympic Boulevard, Los Angeles 64, California

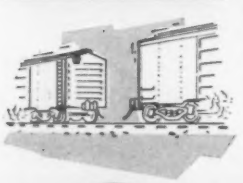
Vibration-proof joints



now made quickly, economically with new

TOWNSEND VERSA-LOCKBOLT





With the new Townsend Versa-Lockbolt* you get the same high tensile values as with the standard type but they cost less and are easier to install.

Wider grip ranges in a given size are provided by additional locking grooves. Other design changes make it feasible to use them in relatively oversized holes. Inspection time is reduced since hole size is less critical.

These features make for flexibility of design—make calculations simpler and more accurate.

Versa-Lockbolt installation is fast and guns provide uniform draw down or clinch —locking the collar with up to five tons of pressure. The new collar with its flanged integral washer makes it especially suitable for fastening even light gage materials.

For more information on how to get new vibration-proof fastening economy, write Townsend Company, P.O. Box 237-E, New Brighton, Pa.

*Licensed under Huck patents RE 22,792; 2,114,493; 2,527,307 2,531,048; 2,531,049 and 2,754,703

The Fastening Authority

Townsend

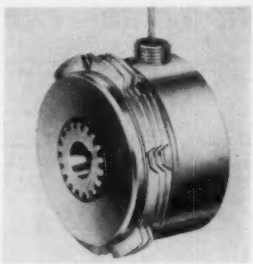
COMPANY • ESTABLISHED 1816

NEW BRIGHTON, PENNSYLVANIA

Sales Offices in Principal Cities

Cherry Rivet Division • Santa Ana, California

netism, assuring positive floating neutral which will not creep, drag, or heat. There are no frictional contacts between moving and stationary units other than coil housing bearings. Clutch disengages in



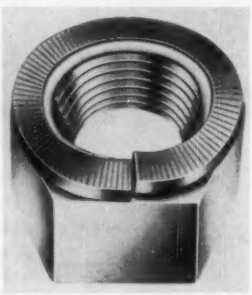
case of current failure or safety device cutout. Standard operating voltage is 90 v dc at low wattage. **Carlyle Johnson Machine Co.**, Manchester, Conn. B

Circle 692 on Page 19

Nut and Lock Washer

preassembled units are available semifinished

Preassembled nuts and helical-spring lock washers, designated Spring-Nuts, are now available in semifinished types, in materials including steel, brass, aluminum, and stainless steel. Units are available



in all commercial sizes. **Jacobson Nut Mfg. Corp.**, Box 177, Kenilworth, N. J. D

Circle 693 on Page 19

Brass-Plated Steel

is available in heavier plating thicknesses

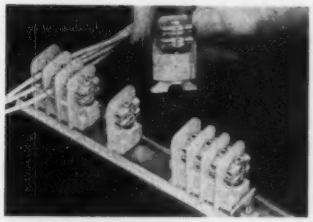
Brass-plated steel is now available in premium grade in 24-in. widths and standard grade in 32-in. widths, both with heavier plating thicknesses than previously offered. Material combines decorative properties of brass with utility and economy of steel. Brass finish is protected with

clear baked resin film that gives excellent protection and does not limit fabricating properties of metal. Material, which is formed easily into many shapes, is available in bright and satin finishes and unpolished, with heavy, pure brass surface to allow for polishing after fabrication. American Nickeloid Co., Peru, Ill. I

Circle 694 on Page 19

Terminal Blocks

can be assembled on steel tracks



Modulok terminal blocks incorporate modular construction which allows individual modules to be snapped together or apart, inserted onto a steel track, and locked by end locks. Modules are Zytel 31 nylon plastic, having extremely low water - absorption characteristics. Tracks are available in lengths up to 32 in., and 30 modules can be mounted per foot of track. Modules have either two or four-tier, spring-loaded plated sockets which can be set for quick disconnect for rapid ring-out, bussing, or circuit changes. Spring-loaded sockets exert continuous, uniform pressure in either position. Solderless, crimp-type contact tips installed on wire ends are inserted into sockets and provide high reliability and speed of assembly. Blocks accommodate wire sizes No. 22 to No. 12. Omaton Div., Burndy Corp., Norwalk, Conn. B

Circle 695 on Page 19

Flange-Mounted Clutch

for minimum-space applications

Style SM flange-mounted, stationary-field, coupling-type clutch is furnished with a mounting flange 2⅛ in. square and 1 9/16 in. long, including armature and driven hub, and 1 in. long without armature and hub. It is intended for applications with a minimum of space available. Clutch is furnished with

MICRO-BEARING ABSTRACTS

by A. N. DANIELS, *President*
New Hampshire Ball Bearings, Inc.

BEARING FITS AND FITTING PRACTICES

As shown in *Fig. 1*, the fitting of Micro-Bearings, like the fitting of larger ball bearings, chiefly involves the clearances between the inside diameter of the housing and the outside diameter of the bearing; the bore of the bearing and the shaft diameter.

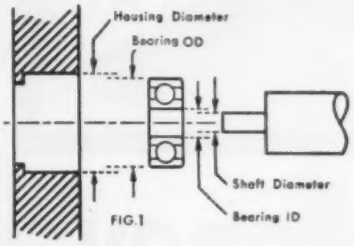


FIG.1

The achievement of the desired fit by dimensioning is illustrated in *Fig. 2*. The bearing ID is represented by the top blocks and the shaft OD is represented by the lower blocks. Such a block diagram could also be applied to housings and bearing outside diameters. In this block diagram, it will be noted, the bearing ID is represented by a .00015 tolerance with a similar tolerance for the shaft. A resulting fit of line to line to .0003 loose is shown.

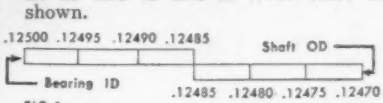


FIG.2

An interference fit not tighter than line to line is suggested for the following reasons:

1. *Difficulty in assembly.*
2. *Difficulty in disassembly. This is often more hazardous than the assembly operation and may result in total bearing destruction.*
3. *Reduction in radial play.*
4. *Danger of bearing ring conforming to possible poor geometry of mating shaft or housing.*

TOLERANCE DISTRIBUTION

The maximum .0003 loose condition shown in *Fig. 2* may be excessive in some applications. The fitting problem then resolves itself to reducing this extreme, and yet maintain the maximum tight fit of line to line. The looseness may be reduced by redimensioning the shaft to .12490/.12475 as shown in the block diagram, *Fig. 3.*

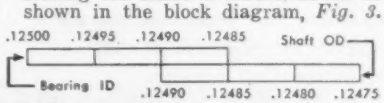


FIG.3

If the frequency distributions of shaft and bearing ID sizes were statistically normal, the modal fit of all parts would be 0.0001 loose. Accordingly, an insignificant percentage of parts would be mated to the extreme values, and for practical purposes could be ignored.

With regard to bearings' outside diameters and bores, however, normality of the distribution curve cannot be assumed. During the grinding operation, the "most metal tendency" tends to skew the frequency distributions for bearing ID's and OD's in the direction of most metal.

In grinding and finishing shafts and housings, similarly skewed distributions occur.

Operating on a modified probability distribution of tolerance is possible if the volume of parts is sizeable. But the approximate distribution of shaft and housing sizes must be verified if this method is to be used.

MATERIALS and SURFACE FINISHES

The ease of assembly is also affected by materials and finishes. The following factors must be considered:

1. *The galling characteristics, hardness and ductility of the materials involved.*
2. *Finish lay patterns produced by various tools and techniques used.*
3. *R M S surface finish values achieved.*
4. *Geometry of shafts and housings as regards out-of-roundness, taper, etc.*

The possible combinations of these elements in any single application are so numerous that their gross effect can only be ascertained by trial and error, or by a detailed study of operations on individual applications. A more complete discussion of fitting practices, including sizing methods and coding, is found in our design handbook.

DESIGNERS HANDBOOK FREE TO ENGINEERS

If you work with miniature bearings, you'll find this new, 70 page authoritative publication a great help in solving problems in designing instruments or small electro-mechanical assemblies.

It will be sent free to engineers, draftsmen and purchasing agents. Write to:

NEW HAMPSHIRE BALL BEARINGS, INC., PETERBOROUGH 1, NEW HAMPSHIRE

Circle 511 on Page 19

BEFORE...
Separate Bolts, Nuts and Washers complicate inventories, increase assembly costs.
AFTER...
Washers as integral parts of bolts and nuts eliminate problems, speed assembly at lower cost.

Save Money

by simplifying fastener design

Here is a simple application of a basic bolt making principle which is affecting substantial savings for a number of manufacturers.

These savings, resulting from simplified design, are realized in every step of the operation from lower first cost of the fasteners through inventory to final assembly. Totalled, they are well worth while.

There are many other basic principles . . . often overlooked in designing and specifying fasteners, which are of importance cost-wise.

You'll find them in our new booklet, "How to specify fasteners . . . and save". Filled with drawings and charts, it makes a handy guide in designing or buying any headed parts.

If you can use a copy, write to North Tonawanda or ask a Field Representative.

BUFFALO BOLT COMPANY

Division of Buffalo-Eclipse Corporation

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MAKING BOTH FASTENERS AND FRIENDS FOR 100 YEARS

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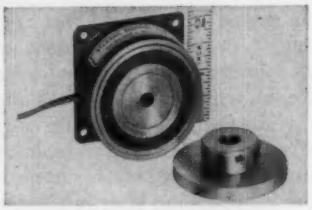


a coil suitable for operation on any dc source with voltages up to 90 v dc. Static torque rating is 30 lb-in. **Stearns Electric Corp.**, 120 N. Broadway, Milwaukee 2. Wis. K

Circle 696 on Page 19

Electrical Heaters

thin, flexible units are for electronic equipment

Thermal-Heaters are thin, flexible, lightweight units, available in various sizes and shapes, for airborne and electronic equipment applications. Typical unit is a 43-w circular heater weighing less than ¼ oz, including 12-in. leads. It is less than 0.030 in. thick over the element and less than 0.065 in. thick over the leads. Heater can be clamped or cemented in place. Flexible construction permits appli-

cation to flat or curved surfaces. Insulation resistance is 1000 v rms. **Minco Products**, 740 Washington Ave. N, Minneapolis 1, Minn. J

Circle 697 on Page 19

Lever-Operated Valves

are only 1 in. thick and 3 in. wide

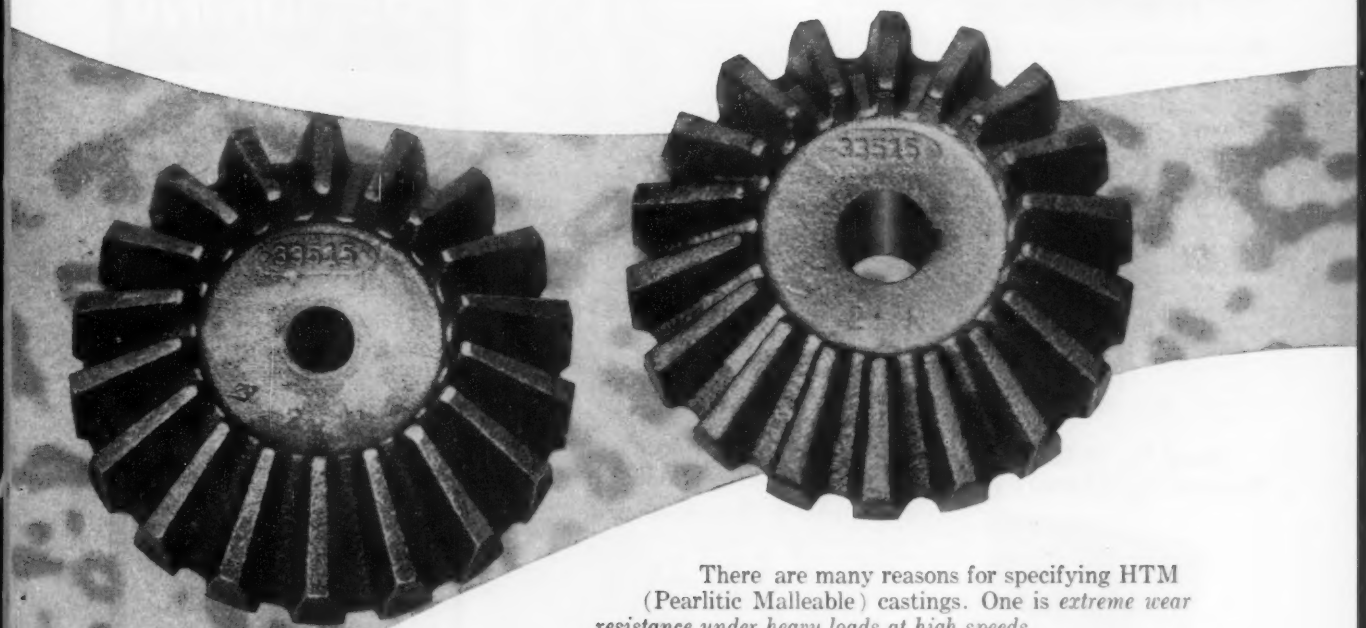
Slim Line lever-operated valves can be mounted easily on machines and machinery when space is extremely limited. They are suitable for air, oil, or water service, for pressures to 125 psi, and temperatures to 150 F. Valves are tapped for either ⅛ or ¼-in. pipe connection. Only 1 in. thick and 3 in. wide, valves are furnished in three and four-way actions, manually operated both di-

is your problem

wear resistance?

NATIONAL HTM CASTINGS

are the answer



There are many reasons for specifying HTM (Pearlitic Malleable) castings. One is *extreme wear resistance under heavy loads at high speeds.*

But there are many other reasons, too. For example, close as-cast tolerances can often eliminate machining operations such as on the gear teeth shown above. In this case, it was only necessary to drill and machine the key slot.

Other worthwhile advantages of HTM are high ultimate strength . . . excellent non-seizing bearing qualities that can eliminate costly bushings . . . air or liquid quenching . . . ability to be smooth-finished.

So when you're looking over the materials field, don't overlook the advantages of HTM castings. For HTM metal can be cast by either the shell mold, CO_2, or green sand method. This means production costs tumble . . . performance and saleability of your product go up.

AA-6928

IMPORTANT PHYSICAL PROPERTIES	
Brinell	163 to 302*
Yield, psi	48,000 to 85,000*
Ultimate, psi	70,000 to 110,000*
Elongation, %	7 to 2*

*Depending upon grade

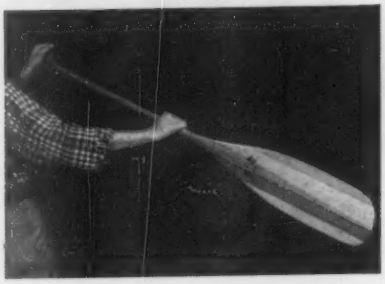
Circle 513 Page 19

NATIONAL MALLEABLE and STEEL CASTINGS COMPANY

Established 1868 *Cleveland 6, Ohio*

The nation's largest independent producer of malleable and pearlitic malleable

WHAT'S YOUR WOOD PROBLEM?



Gamble research even improves *BOAT PADDLES!*

THE PROBLEM: The armed forces' solid wood life raft paddles often shattered when dropped from a plane, or splintered when used to "pry" a landing craft onto a beach.

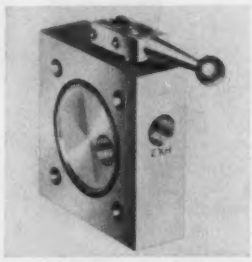
THE RESULT of Gamble testing and development: a paddle with a lightweight laminated blade (for shatterproof quality and resiliency) and a dense hardwood handle (for strength and rigidity). Besides being stronger and lighter, the paddle is made inexpensively — less wasted wood than in solid paddles. Woods better suited for the differing functions of blade and handle can be used — with no sacrifice of strength at the connection of your blade and handle! Perhaps Gamble could help with *your* wood problems.

Send for FREE booklet Illustrating GAMBLE services

This 28-page booklet describes Gamble facilities and services in detail. Includes many photographs of unusual products designed, tested and perfected by Gamble Brothers. Write for your copy today! Gamble Brothers, Inc., 4619 Allmond Avenue, Louisville 9, Ky.

GAMBLE BROTHERS
Incorporated
Louisville 9, Kentucky
If the problem involves WOOD —GAMBLE can help!

Circle 514 on Page 19



rections, or spring return. Valve housing is milled from solid aluminum bar stock, and stainless-steel plunger is hollow and radially ported. Valves can be manifolded together easily and quickly, without special parts, in any of four 90-deg-angle positions. **Hunt Valve Co.**, Salem, Ohio. G

Circle 698 on Page 19

Metallic Texture Finish

for metals, plastics, wood, ceramics

Tri-Namic one-coat finish provides a three-dimensional metallic texture finish when sprayed onto all production metals, many plastics, wood, and ceramics. Finish is available in a wide range of colors and has an excellent consistency of pattern. Air or bake drying provides excellent durability, high corrosion resistance, and high gloss and color retention. **Universal Paint & Varnish Inc.**, Bedford, Ohio. G

Circle 699 on Page 19

Pressure-Overload Unit

protects instruments against pressure surges

Gage Gard Jr. offers positive protection for such instruments as incline manometers, draft gages, electrical pressure switches, and sensitive low-pressure transducers. Designed for either atmospheric or relative pressure system applications, the unit is repeatable and will reopen after sealing at 2 per

LimiTorque ACTUATORS

for

UP OR DOWN

OR ROTARY POSITIONING

LimiTorque actuators are efficient, sensitive, automatic heavy duty power-operated units *for positioning machine parts or other assemblies requiring Linear or Rotary Motion.*

LimiTorque is an electro-mechanical mechanism, using motor power through highly efficient and precision gearing, to impart Linear or Rotary motion . . . Limit switches are available to limit the travel in either direction—Thrust and Torque responsive switches control thrust or provide emergency shut-off. With LimiTorque it is possible to control full travel accuracy to within .2%—LimiTorque is easily and accurately controlled by the mere "push of a button".

LIMITORQUE IS BACKED BY 30 YEARS' EXPERIENCE IN MOTORIZING ALL TYPES OF VALVES—WHY NOT CONSULT US REGARDING ANY PROBLEM YOU MAY HAVE INVOLVING LINEAR ACTUATION; OUR ENGINEERS CAN NO DOUBT HELP YOU SOLVE THAT PROBLEM.

LimiTorque®
PHILADELPHIA GEAR CORPORATION
ERIE AVE. & G STREET, PHILADELPHIA 34, PENNA.
Offices in all Principal Cities
INDUSTRIAL GEARS & SPEED REDUCERS
LIMITORQUE VALVE CONTROLS
FLUID MIXERS • FLEXIBLE COUPLINGS
Limitorque Corporation • Philadelphia

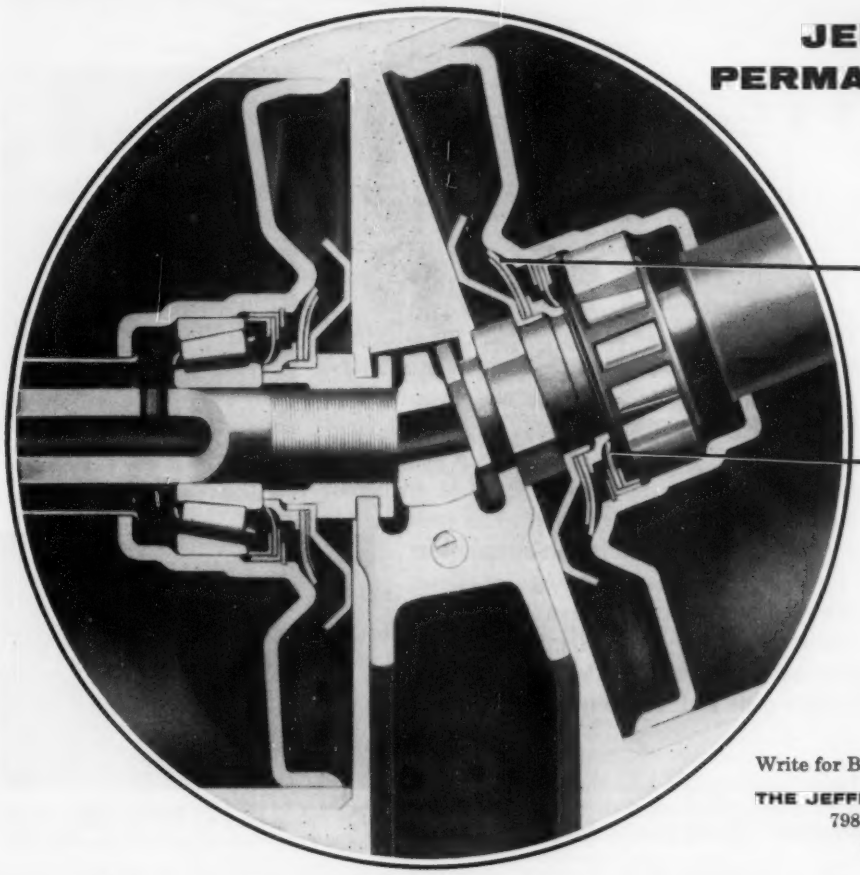
Circle 515 on Page 19

"One lubrication every two years, more than sufficient"

Just part of the glowing report on the performance of Jeffrey PERMASEAL® Belt Idlers from the superintendent of Pennsylvania Railroad ore docks in Philadelphia. He further stated: "PERMASEAL Idlers have extended greasing periods from months to years." They have been on the job since November, 1953.

New seal construction, efficiently designed roller units, dependability, and long life combined with precision manufacture provide unmatched performance. You'll find Jeffrey idler design superior to anything offered today for belt conveyor service.

JEFFREY PERMASEAL® IDLERS



Magnified view of the heart of the PERMASEAL IDLER—shows double flexible diaphragm seals, bearings, and welded roll ends.

Write for Bulletin No. 925

THE JEFFREY MANUFACTURING CO.
798 North Fourth Street
Columbus 16, Ohio

JEFFREY

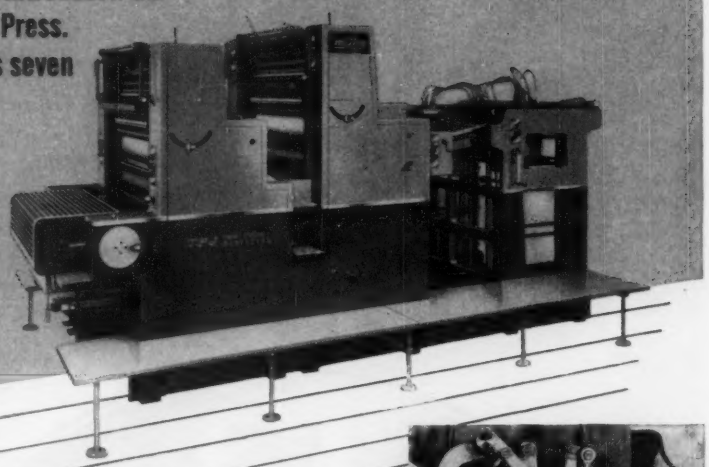
CONVEYING • PROCESSING • MINING EQUIPMENT...
TRANSMISSION MACHINERY...CONTRACT MANUFACTURING

Misalignment is compensated for *Automatically*

The Miller Printing Machinery Co. has introduced the Miller TPJ Two Color-Perfector Offset Press. In the design of this press, Miller uses seven

HEIM *Unibal*®

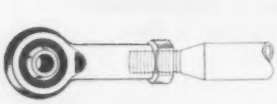
SPHERICAL BEARING ROD ENDS

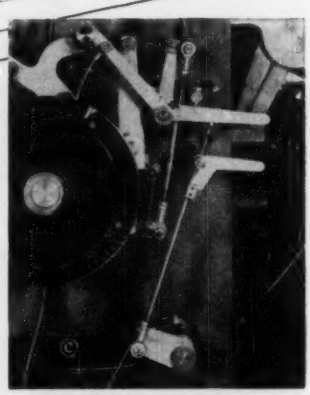


The TPJ is a sheet-fed offset press which converts from printing two colors on one side of the sheet to one color on both sides of the sheet. It can be switched from one to the other in a matter of minutes. It operates at high speeds and prints sheets up to 23" x 36".

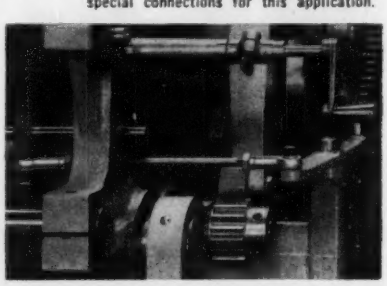
These were chosen for several reasons, the principal one being that dimensional and squareness tolerances do not have to be held as close when using the Unibal, as any misalignment is compensated for automatically. The Heim Unibal has a single ball rotating in bronze raceways housed in an outer member or cartridge. The single ball has universal motion to correct misalignment . . . the larger surface supporting area offers greater load ratings for substantially smaller dimensions . . . assembly is simple and fast . . . there is a wide choice of sizes in both male and female types.

Heim bearings are sold through the country's leading bearing distributors. Write for complete catalog and/or engineering help.





Major section of the first unit trip linkage, where Unibal Rod Ends were chosen to compensate for any slight misalignment, and because they are less expensive than special connections for this application.



Portions of the side guide operating mechanism showing the use of Unibal Rod Ends to connect a walking motion operated by a face cam to a transverse motion.

THE HEIM COMPANY

FAIRFIELD, CONNECTICUT

SPECIFY HEIM UNIBAL SPHERICAL BEARINGS AND ROD ENDS FOR ALL PUSH-PULL AND LINKAGE APPLICATIONS AND WHERE MISALIGNMENT MUST BE COMPENSATED FOR

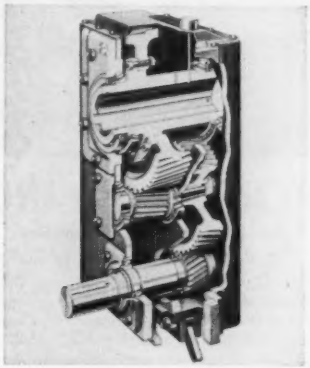
cent below cut-off point. Cut-off pressure point can be adjusted and reset at any time. Maximum allowable pressure after cut-off is 300 psi. Device is available in four ranges, covering a span of −15 to 85 psig. Unit is 3¼ in. high and weighs 11 oz. **Industrial Engineering Corp.**, 525 E. Woodbine, Louisville, Ky. G

Circle 700 on Page 19

Shaft-Mounted Drive

has torque rating of 41,000 lb-in. at low-speed shaft

Size 315GJ all-steel, shaft-mounted drive, with ratio of 25:1, covers a range of applications from 3 hp at 5 rpm to 30 hp at 50 rpm. It has torque rating of 41,000 lb-in. at the low-speed shaft. High-pressure-angle helical gears have 12 to 15



per cent greater load-carrying capacity and mechanical efficiency than other helical gears. Three-walled steel housing maintains rigid alignment of revolving elements and withstands external impact. **Falk Corp.**, Dept. 255, 3001 W. Canal St., Milwaukee 1, Wis. K

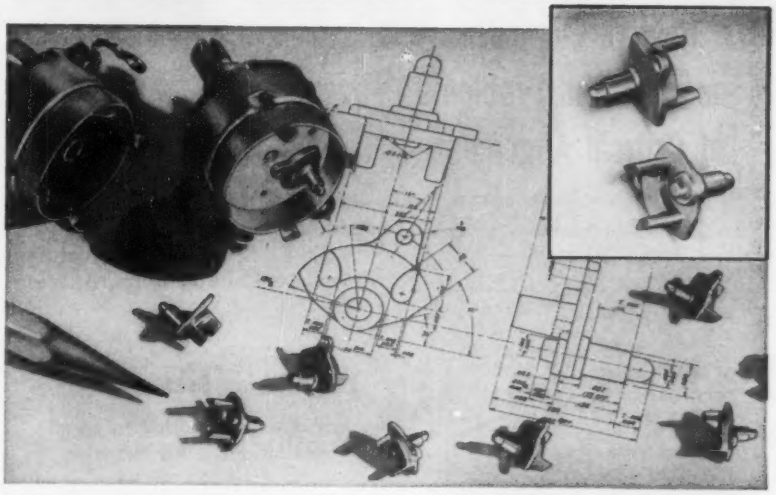
Circle 701 on Page 19

Small Thermostat

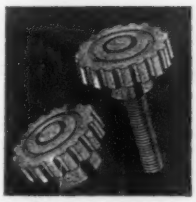
for precision applications weighs only 4 grams

M201 thermostat is available in special constructions for high impact loads, up to 20,000 g, and for high and low-temperature use. It can be used where space and weight accommodations are limited, since over-all diameter is about ⅝ in. and weight is only 4 grams. Switch action is single pole, single throw, with double contact make and break. Actuating element is a thermal disc. Unit is enclosed with-

ACCURACY OF TINY GRC DIE CAST PART AIDS MALLORY SWITCH DESIGN



GRC'S EXTRA WIDE ROUND THUMB NUTS & SCREWS EASY TO GRIP



These unique and exclusive fasteners originated by Gries have large round heads with fluted edges, exceptionally attractive and easy to grip. Nuts are die cast in zinc alloy in both open end and closed end styles. Screws are available as a one-piece die cast zinc alloy fastener with rolled threads in plain or shoulder type and as a two-piece assembly in shoulder type only incorporating die cast zinc alloy thumb nut blanks with steel machine screws. Sizes, lengths, etc., in GRC's new Fastener Catalog. Write for copy.

GRC MOLDED NYLON FASTENERS OFFER MANY ADVANTAGES

Gries' unique techniques make the most of nylon's outstanding properties —high strength to weight ratio, excellent insulation, resiliency, resistance to abrasion, chemicals, corrosion, etc. Molded nylon machine screws in standard commercial heads, slotted or Phillips type; headless set screws with various types of points; screw insulators and bushings with wide flanges to completely isolate screw from mounting surface; washers. Wide range of types, sizes, lengths, etc. Ask for spec sheets and new Fastener Catalog.

Uniformity and detail of actuator contours essential to proper functioning of special switch

A difficult parts design problem was solved with this tiny GRC die cast zinc alloy actuator which forms the basis of the Mallory OAC Line Switch for radios, television sets, record players and electronic equipment.

In a series of designs that started with a stamping and a screw machine piece involving multiple part assembly, Mallory engineers sought an actuating mechanism for a switch that would be capable of higher rating, longer life and greater dependability than switches using current-carrying springs. Such a control would require exceptional tolerances and critical dimensions to function properly. Uniformity would have to be assured as some of the contours couldn't be subjected to normal inspection procedures.

They found the answer in Gries' exclusive patented methods for the precise automatic production of tiny parts, and literally designed the switch around the GRC die casting.

Uniformly accurate, well within critical tolerances and solidly durable, this GRC actuator makes possible the simplest of switch construction.

This is just one of the many instances in which Gries' ingenious methods have opened the door for new products —at substantial savings. Parts are delivered ready for use . . . assembly and other secondary operations are eliminated.

For more information ask for the GRC bulletins on small zinc alloy die castings and molded plastic parts or send prints for immediate quotations. Maximum sizes 1¾" long, ½ oz. in zinc alloy; 1¼" long, .03 oz. in plastic. No size too small.

WORLD'S FOREMOST PRODUCER OF SMALL DIE CASTINGS

GRIES

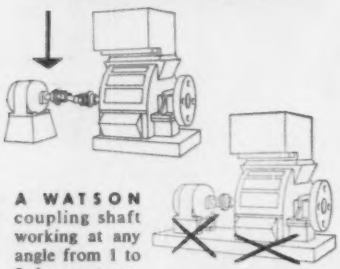
GRIES REPRODUCER CORP.

32 Second St., New Rochelle, N. Y. • NEw Rochelle 3-8600

Circle 518 on Page 19

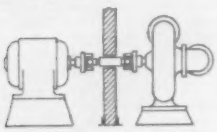
WATSON COUPLINGS Engineering Notes

How to Eliminate the Cost and Problems of Critical Alignment

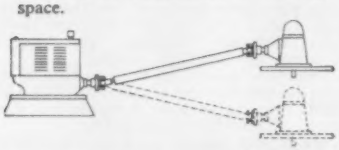


A WATSON coupling shaft working at any angle from 1 to 8 degrees transmits power as efficiently as a flexible coupling, yet offers substantial savings in design engineering time and installation cost. Angles up to 20 degrees can be handled (depending on RPM). No painstaking axial alignment is required; simple, low-cost concrete foundations poured on the site replace costly unit base plates.

In addition to substantial savings in engineering design and installation time and cost, the use of WATSON coupling shafts offers:



WIDEST LATITUDE IN LOCATION of driving and driven elements for best utilization of space, distribution of weight, isolation of motor or engine, provision for maintenance or working space.



PROVISION FOR RELATIVE MOVEMENT between driving and driven elements, either intentional or as a result of structural deflection or foundation shifts.

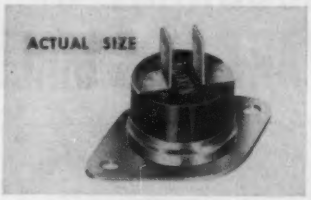
WATSON Coupling Shafts are promptly available in 9 sizes, 10 to 800 h.p., for speeds to 4,000 r.p.m. and more. Why not get the facts — now. 8-page Engineering Data Bulletin F-11 is yours for the asking; please address Dept. J-12.

WATSON **H. S. WATSON COMPANY**

1316 - 67TH ST., EMERYVILLE 8, CALIF.

1606 LASKEY ROAD, TOLEDO 12, OHIO

Circle 519 on Page 19



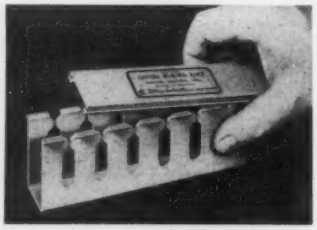
in a stainless-steel cup to provide protection from dust and dirt. Life cycle is from 6000 at 12 amp to 100,000 at 2 amp, 120 v ac. Temperature settings range from −85 to 500 F. **Spencer Thermostat Div., Metals & Controls Corp.**, Attleboro, Mass. B

Circle 702 on Page 19

Vinyl Wiring Duct

rigid unit is slotted to speed installation of lugged wires

Type O wiring duct is extruded from high-impact rigid vinyl plastic which is oil and acid-resistant and self-extinguishing. Equipped with slots instead of holes to speed installation of large lugged wires on control panels, switchgear, and electronic consoles, duct eliminates harness lacing or lug attachment after assembly. It holds all wires in place with snap-on cover. Standard sizes range from ⅜ x ⅜ section to 4 x 3 in. section, in stand-



ard lengths up to 12 ft. Duct can be cut with any hand tool. **Taylor Electric**, 15400 Dale, Detroit 23, Mich. H

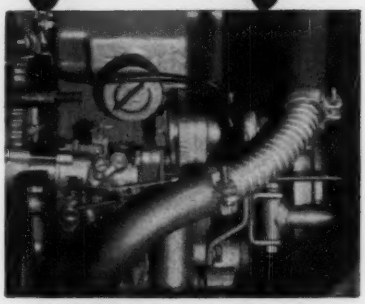
Circle 703 on Page 19

Check Valve

is unloaded by depressing external plunger

Spring-loaded controllable check valve provides easy, positive control of systems in ground-support equipment and other exacting applications. Valve permits free flow in one direction and checks reverse flow until it is unloaded by depressing external plunger. Unit requires

Old Time
RELIABILITY
Teamed with Modern
FLEXIBILITY



PENFLEX TUBING

Absorbs Engine Vibrations On Replica of Old Time Car

When Dyer Products Co., Canton, Ohio, started production on the "Surrey"—new replica of antique car—they wanted to keep engine vibration at a minimum and reliability at the maximum. They specified Penflex interlocked galvanized steel on the tiny motor.

The result has been less vibration. Today this "new-old" car is sweeping the country in its uniqueness among antique car lovers and dealers. This is only one example of how Penflex "Flexineering" has helped make good products even better.

Penflex Tubing is available in interlocked, corrugated . . . braided, plain or rubber covered . . . copper, steel, brass or stainless steel . . . from ⅛" to 24" I.D. Penflex makes all types and sizes for all applications and operating conditions. Write for data to Pennsylvania Flexible Metallic Tubing Co., 7239 Powers Lane, Philadelphia.

NEW DATA BOOK
Get Your Copy

PENFLEX
TIGHT AS A PIPE BUT...
FLEXIBLE

Circle 520 on Page 19

Need a "standard" solution to your "special" fastener problem?

Because we make millions and millions of all kinds of fasteners many types are "standards" with us that would be "specials" with some other company. Savings in price and delivery time (very often we deliver "specials" direct from stock) are two benefits you receive through this volume manufacturing.

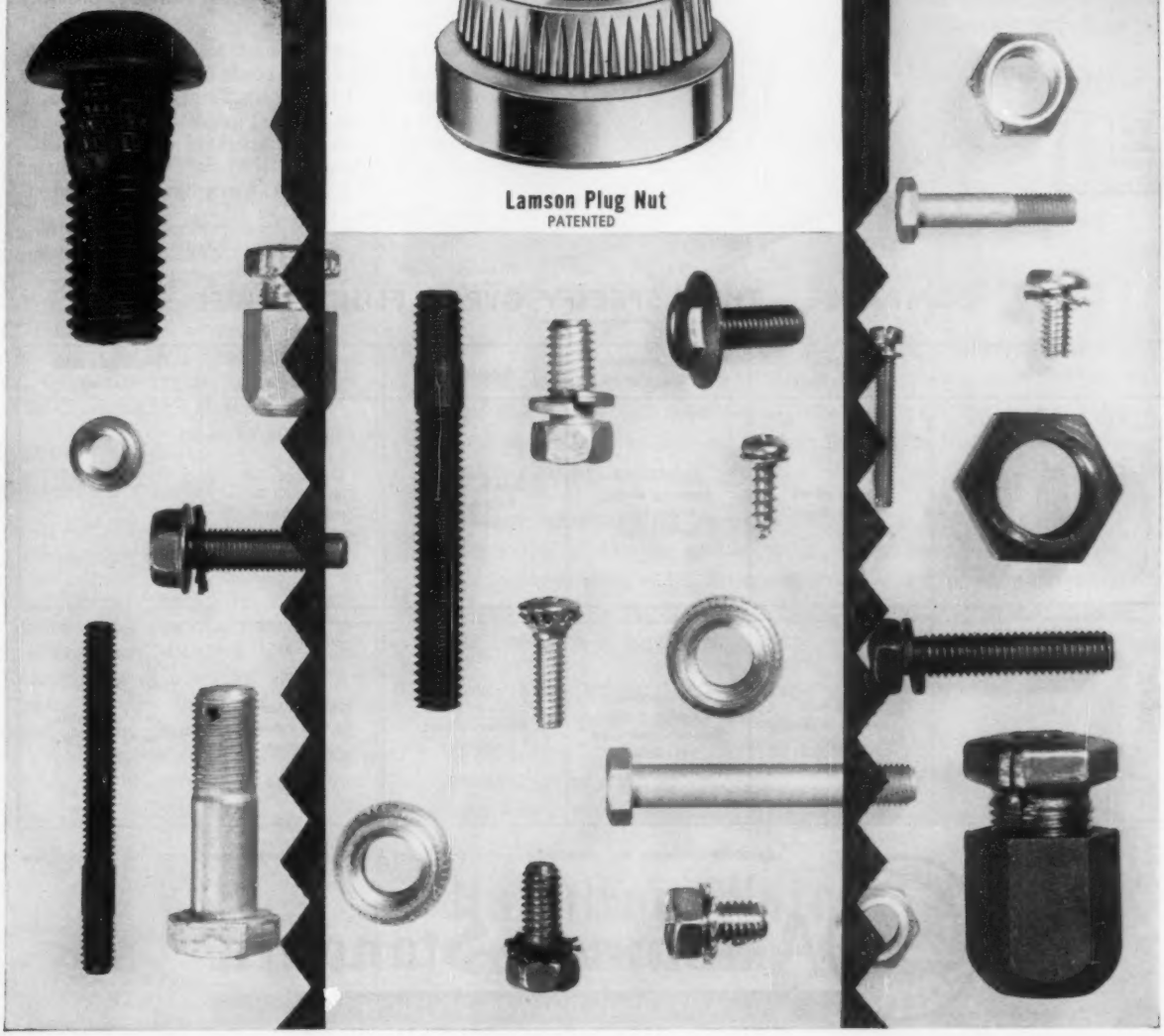
Regardless of type all fasteners are manufactured at Lamson with strict adherence to statistical quality control techniques. Your order will come from one of four plants—two of them brand new and almost entirely automated.

If you have a "special" fastener problem check with us. We probably have a "standard" solution for you.

The Lamson & Sessions Co.

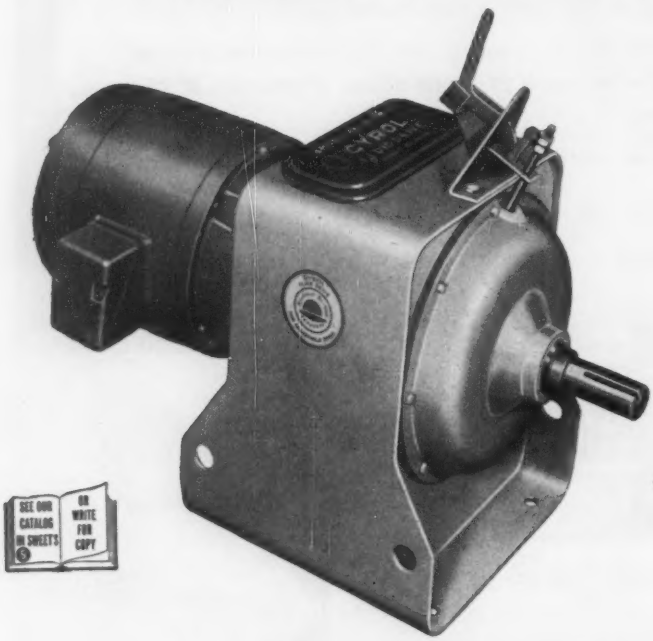
5000 Tiedeman Road, Cleveland 9, Ohio • Plants at Cleveland and Kent, Ohio • Chicago • Birmingham

Lamson Plug Nut
PATENTED



Get full value from adjustable-speed drive:

American Blower *Gýrol*® Fluid Drive varies speed steplessly without costly maintenance

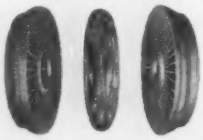


Feature for feature, American Blower Gýrol Fluid Drive is your most economical solution to many industrial-drive problems. Here's why:

- **Stepless speed control**—simple, wear-free speed controller; manual or automatic operation.
- **Shock protection**—vortex of oil isolates shock; protects costly machines.
- **Controlled acceleration**—permits no-load starting—gradual application of power to accelerate the load.
- **Full reversibility**—fast, easy; just change motor rotation even when running; provides dynamic braking.

Compact and self-contained, Type VS, Class 2 Gýrol Fluid Drives come in a complete range of sizes from 1 to 800 hp. Other designs handle up to 12,000 hp. Get full information today from one of our 73 branch offices! Or write: American-Standard*, American Blower Division, Detroit 32, Mich. In Canada: Canadian Sirocco products, Windsor, Ont.

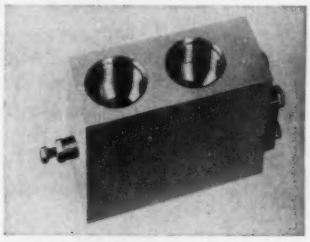
COMPARE . . . THEN SPECIFY *GÝROL*® FLUID DRIVE!

Feature	Shock Protection	Maintenance Record	Accuracy	Service Limit	Horsepower Rating
GÝROL FLUID DRIVE Type VS, Class 2 	Vortex of oil isolates shock.	Good—few wearing parts; extra-long service life.	Simple, wear-free speed control.	Unlimited—all Gýrol Fluid Drive ratings are for continuous service.	Units available up to 800 hp.
FRICTION-TYPE DRIVE	Mechanical connection transmits shock.	Poor—multiple wearing parts; power transmitted by friction.	Wear and tension affect control.	Limited—service factors influence selections.	Units available up to 100 hp.

* American-Standard and Standard® are trademarks of American Radiator & Standard Sanitary Corporation.

AMERICAN-Standard
AMERICAN BLOWER DIVISION

100 lb maximum pressure to unload with 3000 psi on checked flow part. With 25-gpm flow at 3000 psi, pressure drop is 65 psi maximum in free-flow direction and 35 psi maximum in checked-flow position. Valve has zero external leakage and low internal leakage. Small in size, it weighs 3¼ lb, has proof



pressure of 4500 psi and burst pressure of 7500 psi. **Fluid Regulators Corp.**, 313 Gilette St., Painesville, Ohio. F

Circle 704 on Page 19

Brazed Wire Cloth

prevents shifting of wires under vibration

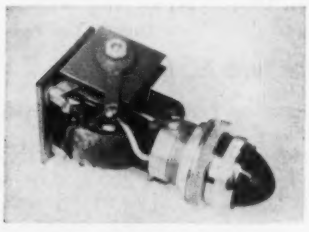
Industrial wire cloth consists of 8 x 8 mesh woven from 0.020-in. diam T-304 stainless-steel wire. Cloth is copper brazed at each intersection after weaving. Brazed joints provide a rigid structure which blocks shifting of wire in any direction during service, even when subjected to severe vibration. **Cambridge Wire Cloth Co.**, Cambridge, Md. C

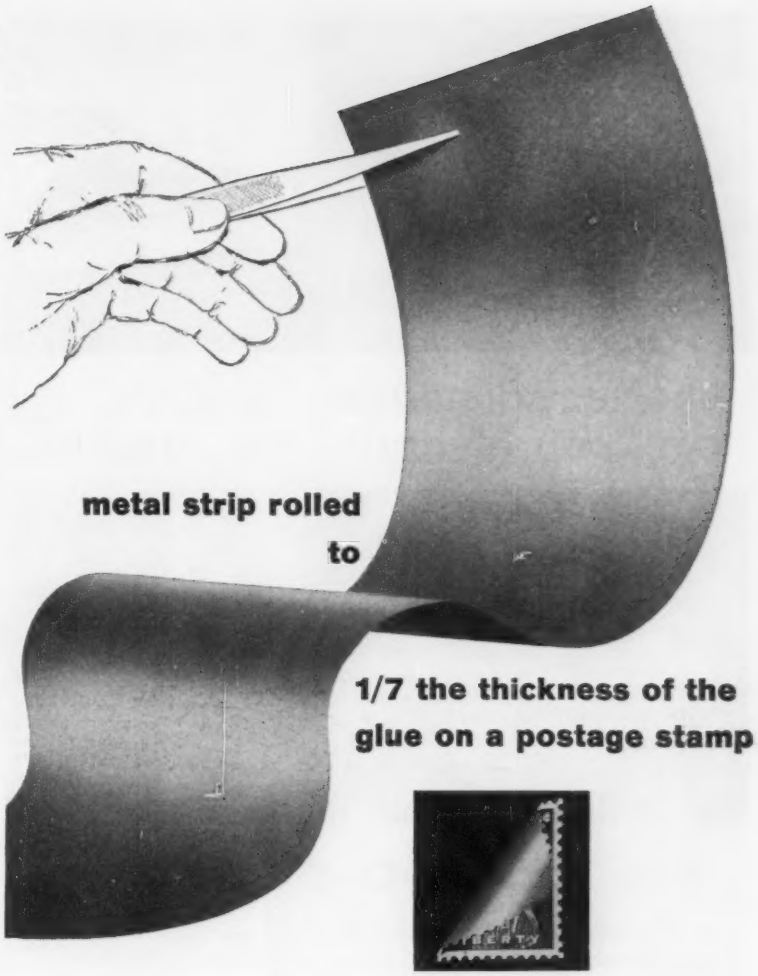
Circle 705 on Page 19

Oiltight Pilot Lights

can be tested in groups by pressing pushbutton

Pilot lights incorporate a small 110/6-v transformer for use on 110-v power with standard 6-v bulb. Through use of a special electrical circuit, all pilot lights on a given panel can be illuminated at once by pressing a test pushbutton. Pushbutton can be pressed at any time





Here is metal strip—available in virtually any alloy—produced in thicknesses ranging from .010" to .0001". (The glue on a stamp measures .0007".) Many of the miniaturization problems facing designers are being solved today by this ultra-thin strip and foil from the Precision Metals Division of the Hamilton Watch Company.

When product emphasis is on compactness and lightness, Precision Metals Division strip and foil will meet your exact mechanical, magnetic and physical specifications. For production orders or the development of new designs, this ultra-thin strip is available in any quantity. Special alloys to your own specification can also be made and furnished in the form you require.

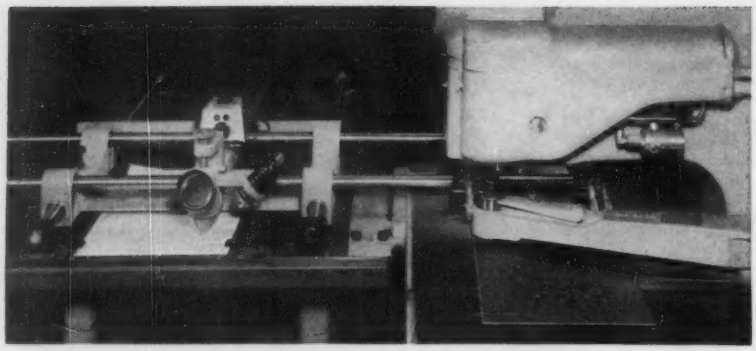
A new 8-page facilities booklet illustrates and describes the operation of the Precision Metals Division, and shows how your precision metals problems can be solved practically and economically. Write on your letterhead today to Dept. MD-12.

Hamilton Watch Company

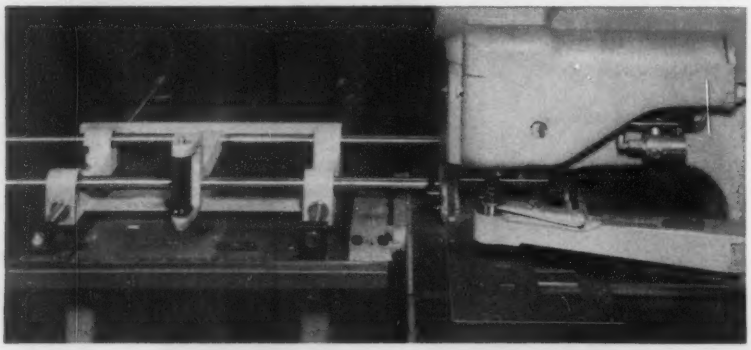
Precision Metals Division / Lancaster, Pennsylvania

Creator of the world's first electric watch

Circle 523 on Page 19



shortest distance
between blueprint and product



The DUPL-O-SCOPE

Firms punching or notching sheets up to ¼" mild steel in medium runs know how profitable it is with a Strippit Fabricator-Duplicator. Now, it's even faster with the new Dupl-O-Scope, which eliminates the template drilling and layout step!

Readily mounted in the Duplicator stylus bracket, this precision optical pickup device quickly translates a drawing, layout or printed circuit sample into a punched metal template — ready for rapid-fire punching and notching on the Fabricator-Duplicator using standard interchangeable tools or "specials" made up to your requirements.

Write today for catalog and an actual demonstration on *your* work at *your* plant by a Strippit Mobile Unit. Warehouse stocks at Chicago and Los Angeles.

The versatile Strippit Fabricator, one-machine shop for quick-change punching, notching and nibbling — available with positive Duplicator for high-speed production punching and notching in complex patterns including printed circuit boards.

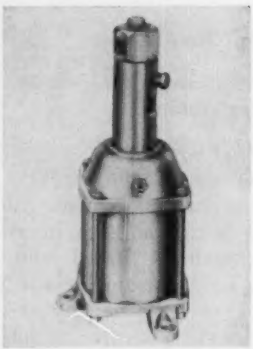
WALES
STRIPPIT
Company
216 Buell Road, Akron, New York
In Canada: Strippit Tool & Machine Limited, Brampton, Ontario

and will illuminate all lights not already on. There is no electrical feed-back between various light circuits. If one bulb in the circuit is burned out and fails to light, a replacement can be made immediately. Number of indicating lights which can be tested by a single button is limited only by ampere capacity of pushbutton and test circuit supply. Components are mounted in a compact unit which is mounted in a 1-in. panel hole. Adapters are available for use in a 1 7/32-in. hole to match present oiltight pushbutton equipment. **ECP Corp.**, 4726 Superior Ave., Cleveland 3, Ohio. G

Circle 706 on Page 19

Air-Hydraulic Boosters

mount vertically rather than horizontally



Air-hydraulic boosters convert instant action of air into hydraulic pressure. Boosters are designed to mount vertically instead of horizontally to prevent weight of internal parts from causing distortion in hydraulic seal. Air filter, threaded into breather hole of air chamber, is made from tiny particles of solid bronze, pressed together to make a fine mesh. External chambers are honed seamless-steel tubing instead of castings, and hardened-steel tie-rods connect air chamber and hydraulic chamber. **Wilton Tool Mfg. Co. Inc.**, Schiller Park, Ill. I

Circle 707 on Page 19

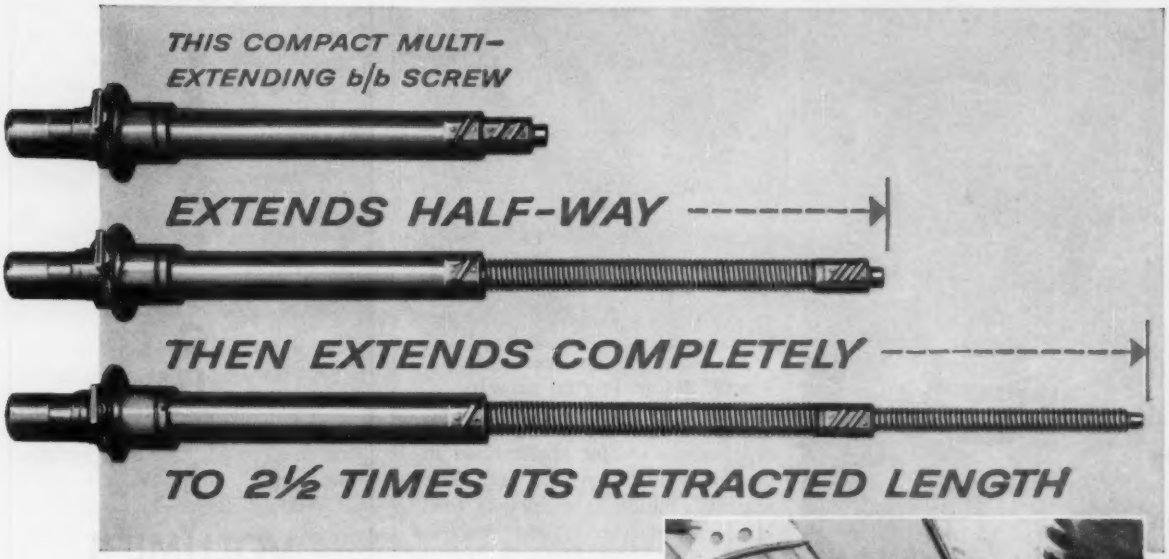
Miniature AC Motor

develops 1/20 hp at 6500 rpm

Model 35YH37 miniature three-phase ac motor is a 200-v, 400-cycle unit which develops 1/20 hp at

Circle 524 on Page 19

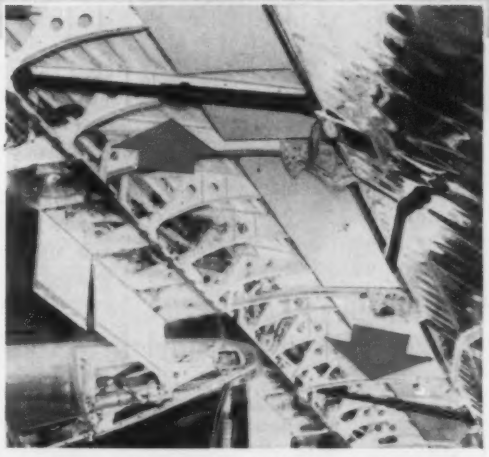
FAR-REACHING EXTENSION FROM LIMITED ACTUATOR SPACE



Now Saginaw supplies the answer to your most difficult actuator space problems with the Multi-Extending Saginaw Screw! Utilizing Saginaw's time-proved *recirculating ball* principle in multiple telescoping sections, the Multi-Extending b/b Screw conquers actuator space obstacles designers have been seeking to overcome for years! Here's why:

1. **UNIT EXTENDS** in a ratio of 2.5 to 1, providing maximum extension 2½ times the length of the retracted screw.
2. **FAR GREATER LOAD CAPACITY** than any other telescoping device in its class.
3. **FAR MORE PRACTICAL AND TROUBLE-FREE** than other telescoping units on the market.
4. **PRECISE, DEPENDABLE POSITIONING** and control within thousandths of an inch.

• OVER 90% EFFICIENCY • REQUIRES UP TO 4/5 LESS TORQUE than acme screws • LESS DRAIN on power supply • CONSERVES SPACE AND WEIGHT • OPERATES DEPENDABLY at extreme temperatures • PERFECT FUNCTIONING with only initial lubrication



USED ON THE COUNTRY'S MOST MODERN AIRCRAFT—Multi-Extending b/b Screw wing flap actuators being installed on the new Lockheed Electra.

The Saginaw Multi-Extending Screw is also used to actuate speed brakes, afterburners, variable air inlets, canopies and similar critical components on today's newest aircraft.

Send today for the new 1959 engineering data book on Saginaw b/b Screws and Splines...or see our section in Sweets Product Design File.

Saginaw

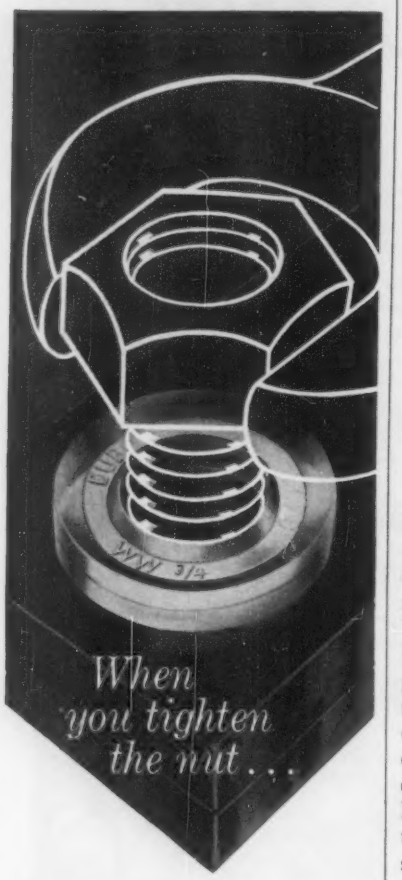
WORLD'S MOST EFFICIENT ACTUATION DEVICE

ball bearing Screw

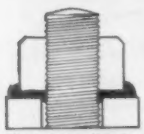
SAGINAW STEERING GEAR DIVISION, GENERAL MOTORS CORPORATION • SAGINAW, MICHIGAN

Circle 525 on Page 19

This new lock and seal washer is just plain **REVOLUTIONARY...**



NYLOGRIP Dubo Lockwasher locks and seals it-instantly!



Patents Applied For

The new NYLOGRIP Dubo Lockwasher is made of a special, cold-flow plastic called Nylon 6. When the nut is tightened, the washer "flows" — its inner diameter grips into the threads of the nut and bolt, to seal this junction against leakage, while the outer diameter flows over the outer edges of the nut, seals and locks it . . . so tight neither shock nor vibration can budge it! The Dubo Lockwasher can be used time and again without the slightest loss of holding power. And, because it's symmetrical and has no threaded parts, you couldn't fit one incorrectly if you tried.

PLUS FEATURES: excellent electrical properties . . . exceptional wear resistance . . . good shock absorption . . . resists corrosion, chemicals . . . non-flammable . . . high flexural strength.

PLUS USES: The excellent electrical characteristics of NYLOGRIP Dubo Lockwashers make them ideal for electrical insulation, or to help control electrolytic corrosion between dissimilar metals.

YOU'LL WANT COMPLETE TECHNICAL INFORMATION.

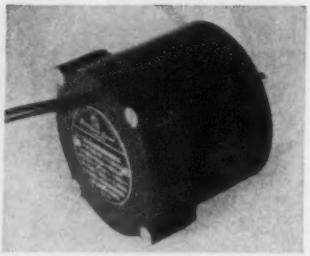
Write today to:

NYLOGRIP PRODUCTS

445 Watertown St., Newton, Mass.-BI 4-0960

Non Metallic Fastenings of all types.

Circle 526 on Page 19



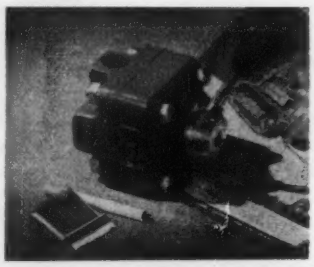
6500 rpm. It draws 0.42 amp, has a diameter of 2½ in., and is 2½ in. long. **Electro Products Div., Western Gear Corp.,** P. O. Box 182, Lynwood, Calif. L

Circle 708 on Page 19

Rotor-Type Valves

are manually operated units with 2½ to 14-gpm capacity

Two, three, and four-way rotor-type valves are for applications including fork-lift trucks and other materials-handling equipment, road-building machinery, and machine tools. Sizes range from 2½ to 14-gpm capacity, with operating pressures to 3000 psi. The manually operated units are available with open or closed center; handles are detent positoned or spring centered. New Cem-Lap seal eliminates internal leakage. Lapped surfaces of seal and rotor glide on each other, wiping, cleaning, and lapping with every handle movement. Removal



of four bolts permits housing to be separated from body. **Clark Engineering & Mfg. Co. Inc.,** 1820 Layard Ave., Racine, Wis. K

Circle 709 on Page 19

Miniature Relay

incorporates a heavy-duty socket

Miniature sealed, electromagnetic relay is designed for industrial applications such as machine-tool controls, welding controls, instruments, and electronic equipment.

TIPS AND TECHNIQUES

VOLUME II ENGINEERING AIDS

- **Simplifying Constructions**
- **Utilizing the Slide Rule**
- **Construction Aids**
- **Shortcuts for the Engineer**

Helpful Tips and Techniques that apply to engineering methods, are now available in this one-volume reference. This manual contains 32 pages of illustrated time-and-money saving procedures that every engineer can use.

$1.00 a copy

Order from

MACHINE DESIGN

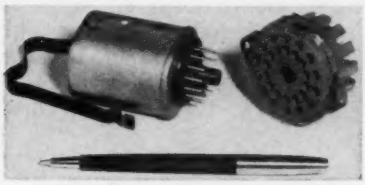
Reader Service

Penton Building

Cleveland 13, Ohio

(Remittance or Company Purchase Order must be enclosed with order)

New 14-terminal header with keyed guide post is mated with a heavy-duty, mica-filled phenolic socket, permitting wire checking and speedy replacement. The four-pole, double-throw unit has minimum creepage of 1/4 in. and is available in ratings up to 5 amp at 28 v dc or 120 v ac. Basic relay is offered with dc coils, and forms with integral rectifiers are available



for 115-v, 60-cycle operation. Unit withstands instantaneous voltage surges up to 1500 v without failure. Operating time with normal voltage applied to coil is 25 millisec maximum, and maximum release time is 5 millisec. **General Electric Co.**, Schenectady 5, N. Y. C

Circle 710 on Page 19

Epoxy Adhesive

is available in stick form

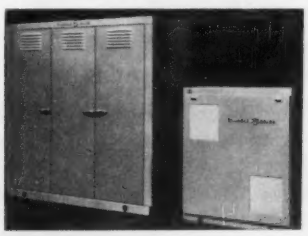
Epistik bonds all types of metals, ceramics, carbides, and carbon to each other or themselves. Any material that can withstand curing temperature of 260 F can be bonded. An epoxy adhesive in stick form, compound is simple to use, seals joints and corners quickly and easily, and has high shear strength. **Robert Marks Co.**, 47 Goddard St., Providence, R. I. B

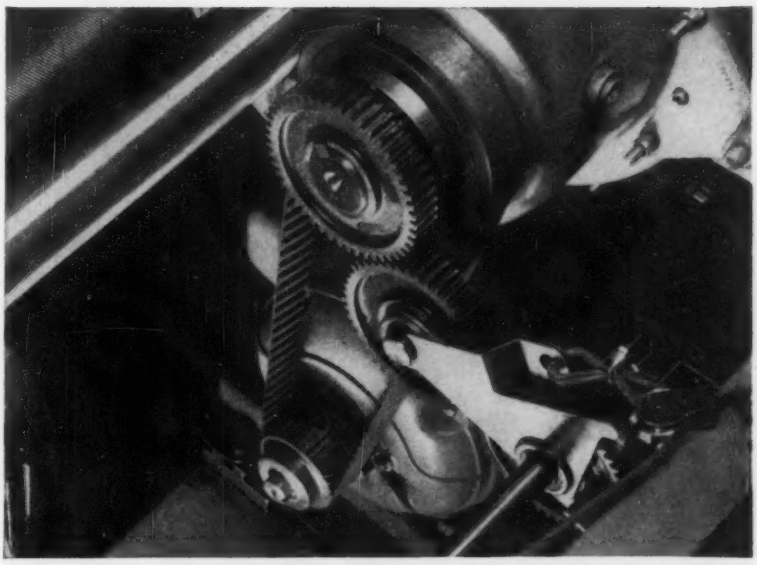
Circle 711 on Page 19

Adjustable-Speed Drive

is 35 per cent smaller than comparable 3 to 350-hp units

Super T adjustable-speed drive is designed around redesigned NEMA ac and dc motors and generators. Incorporating high-temperature Class B insulation, the ro-





Revolutionary Wire Cloth Looms use Wood's Timing Belt Drives to cut rejects . . . speed output

New, radically different wire cloth looms, developed by New York Wire Cloth Company, not only weave screening of exceptional quality, but increase production 50% or more.

An important factor in minimizing defects and maintaining output is Wood's Timing Belt drive. The slip-free, positive action of this drive, together with no belt stretch, eliminate irregularities of mesh . . . help maintain operating speeds never before possible. The compact Wood's Timing Belt drive is used in this loom to replace a multiple V-belt drive. Not only does it satisfy the high efficiency requirements and eliminate matching of belts, it has long life and requires no maintenance, features which permit its use in a relatively inaccessible area.

Wood's Timing Belt drives have a wide range of load capacities, up to 600 hp and above, and cover an exceptional speed range, from zero to 16,000 fpm. Absence of metal-to-metal contact eliminates the need for lubrication. These and many other features make this drive outstanding for a wide variety of applications.

Contact your T. B. Wood's representative for complete information and your copy of Catalog 2100.

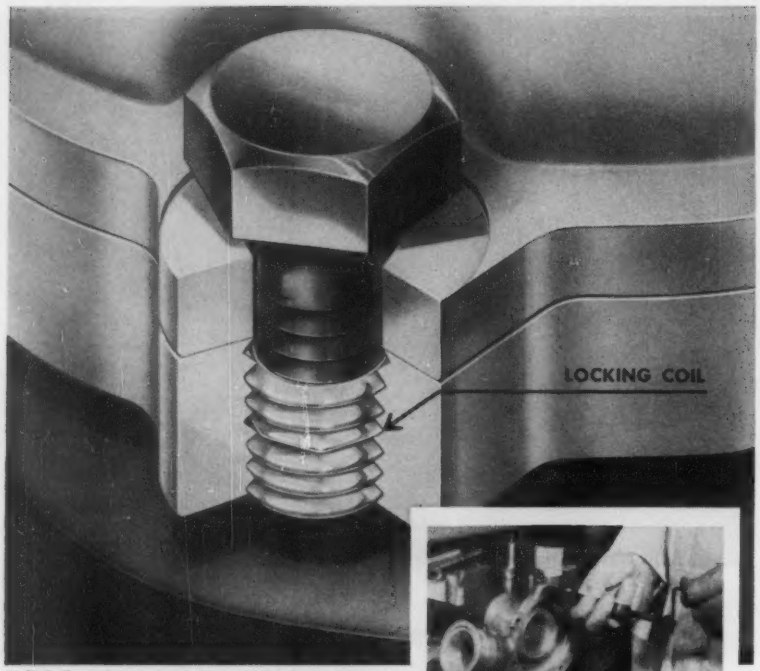
V-BELT DRIVES • VARIABLE SPEED DRIVES • TIMING BELT DRIVES • CARD DRIVES • FLEXIBLE AND RIGID COUPLINGS • FLYWHEELS • PULLEYS • MOTOR BASES • BALL BEARING PILLOW BLOCKS, FLANGE UNITS AND TAKE-UP BEARINGS • BABBITTED AND BRONZE BEARINGS • DUCTILE IRON PRODUCTS

Wood's

T. B. WOOD'S SONS COMPANY
CHAMBERSBURG, PENNSYLVANIA

ATLANTA • CAMBRIDGE • CLEVELAND • DALLAS • NEWARK

Circle 528 on Page 19



Heli-Coil stainless steel Screw-LOCK Insert is easily wound into tapped hole in aluminum housing. Spring tension of the locking coil retains the screw securely, meets military specifications for locking torque and vibration.

How Carrier Corporation Saves 40% in weight • 30% in assembly time ...with HELI-COIL® SCREW-LOCK* INSERTS

... and assures maximum performance of threaded connections in the refrigeration system for air conditioning the giant Douglas DC-8 jetliner.

In assembling aluminum alloy compressor castings, Carrier engineers needed reliable threaded connections that could resist the heat and vibration encountered at 600 mph. They selected *Heli-Coil's* one-piece, *internal locking* Screw-LOCK Insert.

The results: design simplified, boss areas minimized, weight reduced as much as 40%, lock nuts and lock wiring eliminated. Now one man assembles the entire unit in 30% less time than before ... and danger of thread failure has ended!

It's a typical example of why manufacturers in every field are turning to precision formed, stainless steel *Heli-Coil* Screw-LOCK Inserts to meet torque and vibration specs ... to protect threads against wear, stripping, galling and corrosion ... to save costs, space and weight. *Pat. Applied For

HELI-COIL CORPORATION
DANBURY, CONNECTICUT

1552

HELI-COIL CORPORATION, 512 Shelter Rock Lane, Danbury, Connecticut
I'd like more information on *Heli-Coil* Screw-LOCK Inserts

NAME_____TITLE_____
FIRM_____
ADDRESS_____
CITY_____ZONE____STATE_____

IN CANADA: W. R. WATKINS CO., Ltd., 41 Kipling Ave., S., Toronto 18, Ont.

tating unit is 35 per cent smaller than previous units with 3 to 350 hp. Drives commutate up to 200 per cent current for 1 min, and handle higher transitory peak loads. Motor has 60-C rise. Standard and custom models are furnished for normal or complex requirements. Drives have preset speed-control device, and timed acceleration and deceleration. Speed control is available over 8:1 range by armature voltage, and over 4:1 range by field control. **Reliance Electric & Engineering Co.**, 24701 Euclid Ave., Cleveland 17, Ohio. F

Circle 712 on Page 19

Corrosion-Resistant Valve

has driptight, replaceable rubber seat

New corrosion-resistant valve is a lightweight unit of stainless steel or other corrosion-resistant alloy. It incorporates a replaceable rubber

seat which is driptight both ways, eliminating dewatering. Tight shut-off permits use of the unit as a wade gate and stock valve. Valve handles pulp stock, slurries and sludges, pure liquids and gases. It is available in wafer, standard, or special dimensions, with motor or cylinder mount for automatic operation. **W. G. Rovang & Associates Inc.**, 1945 N. Columbia Blvd., Portland 17, Oreg. M

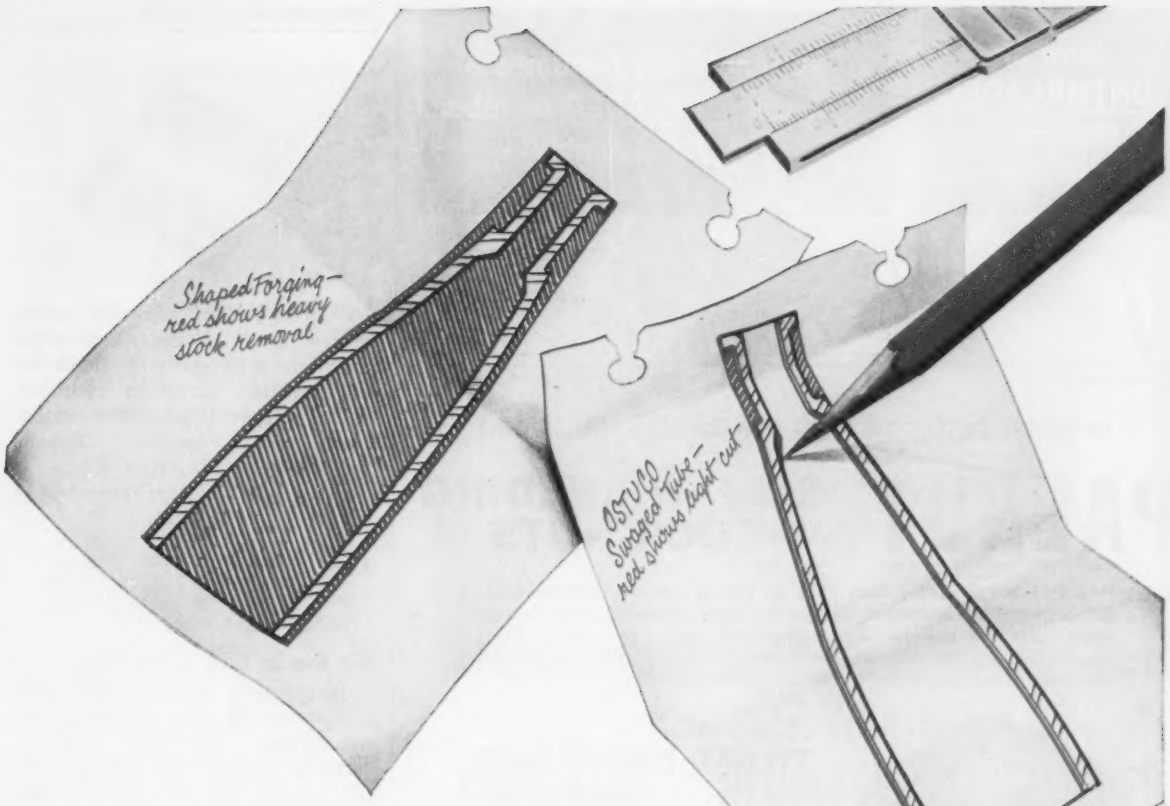
Circle 713 on Page 19

Sliding Motor Base

welded-steel unit has quick-release adjusting screw

Sliding motor base is applicable for wide-range, variable-pitch drives which require provision for more take-up than normal V-drives. Base is of welded-steel construction, and

Circle 529 on Page 19



OSTUCO SWAGED TUBING
ups aircraft parts production 82%

Hogged out of a shaped forging, this vital aircraft part in SAE 4140 took 400 minutes to machine.

So the producers, The "Special" Corporation, brought their problem to Ohio Seamless. The solution—an Ostuco Swaged Tube.

Now the chips are down . . . and so is machining time. Down to 220 minutes—*a saving of 180 minutes per part*—with a whopping 82% increase in parts production per workshift.

Chances are Ostuco Tubing can put *you* on velvet, too. The first step is to contact your nearest Ohio Seamless sales office, or the plant at *Shelby, Ohio—Birthplace of the Seamless Steel Tube Industry in America.* AA-5112

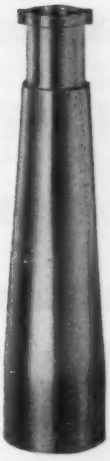


Photo: Courtesy The "Special" Corporation, Brooklyn, N. Y.

FIFTY YEARS
OSTUCO SHELBY, OHIO
OSTUCO TUBING
1908 1958

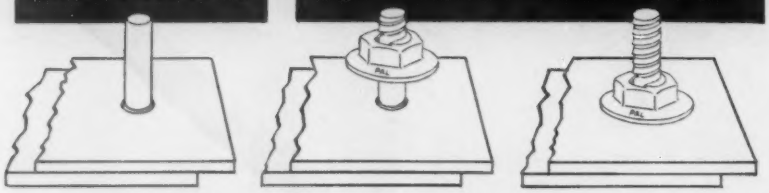
OHIO SEAMLESS TUBE DIVISION
of Copperweld Steel Company • SHELBY, OHIO

Seamless and Electric Resistance Welded Steel Tubing • Fabricating and Forging

SALES OFFICES: Birmingham, Charlotte, Chicago (Oak Park), Cleveland, Dayton, Denver, Detroit (Huntington Woods), Houston, Los Angeles (Lynwood), Moline, New Orleans (Chalmette), New York, North Kansas City, Philadelphia (Wynnewood), Pittsburgh, Richmond, Rochester, St. Louis, St. Paul, St. Petersburg, Salt Lake City, Seattle, Tulsa, Wichita. CANADA: Railway & Power Engr. Corp., Ltd. EXPORT: Copperweld Steel International Company, 225 Broadway, New York 7, New York

How an UNTHREADED stud, rod, wire or rivet...

...automatically becomes a strong THREADED member for tight assembly--



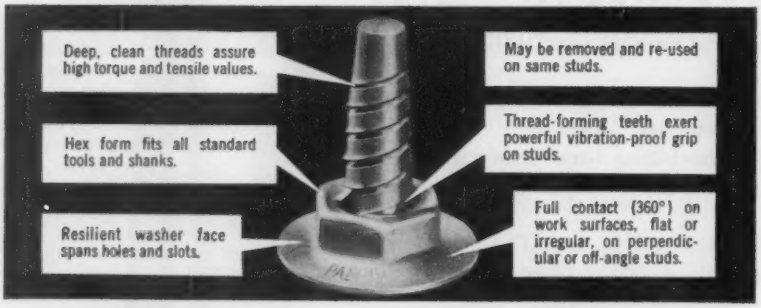
—when fastened with low-cost, high-speed

PALNUT® SELF-THREADING LOCK NUTS

PALNUT Self-threading Lock Nuts are spring-tempered steel fasteners with a special thread-forming design. Fastening operation forms threads while tightening. Effective on zinc, aluminum, steel or brass. Assembly is easy and fast using standard tools—extra fast using PALNUT magnetized wrenches. Hold tight under vibration whether seated or unseated.

TYPE ST--WASHER BASE

This one-piece Self-threading nut performs functions of ordinary nut, lockwasher and flat washer. Available in several base diameters; also with bonded-in plastisol compound to seal out water and dirt. Sizes for 1/8", 5/32" and 1/4" dia. unthreaded studs and rod.


Deep, clean threads assure high torque and tensile values.
Hex form fits all standard tools and shanks.
Resilient washer face spans holes and slots.
May be removed and re-used on same studs.
Thread-forming teeth exert powerful vibration-proof grip on studs.
Full contact (360°) on work surfaces, flat or irregular, on perpendicular or off-angle studs.
PAL

TYPE RST-- REGULAR HEX

This compact Self-threading nut requires shorter stud or rod space, less seating area. Costs less, assembles as fast as push-on nuts, parts stay tighter, can be removed and re-used. May be driven with internal wrench. Sizes for 1/8", 5/32" and 3/16" dia. unthreaded studs and rod.

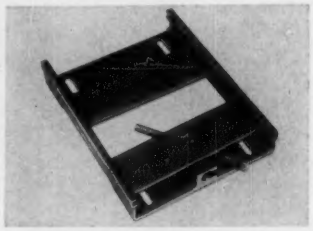
Write for literature and free samples, stating type, size and application.

THE PALNUT COMPANY, 75 Glen Road, Mountainside, N. J.

In Canada: P. L. Robertson Co., Ltd., Milton, Ont.

PALNUT® LOCK NUTS FASTENERS PAL®

Quick, secure fastening at low cost



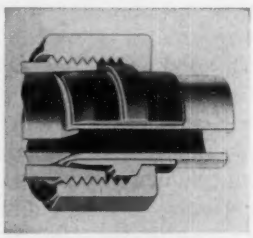
has quick-release adjusting screw. A few turns of the screw allow maximum movement of motor for adjustments. Screw is cadmium plated to provide protection against corrosion and "freezing." **Browning Mfg. Co.**, Maysville, Ky. G

Circle 714 on Page 19

Tube Fitting

self-flaring unit forms pressuretight seal

Self-flaring tube fitting employs a hardened-steel sleeve to press tube into contoured body to form a flare as fitting is tightened. Fitting forms a pressuretight seal on both OD and ID of tube. Slotted skirt on rear of sleeve supports tube, absorbing excess vibration. Nut cannot be overtightened, and fitting can be reused frequently without leakage. Fitting is available in all standard tube sizes from 18 to 2 in. and in all common styles. Mate-



rials available include steel, stainless steel, brass, and aluminum. **Flodar Corp.**, 16911 St. Clair Ave., Cleveland, Ohio. G

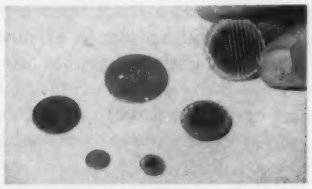
Circle 715 on Page 19

Disc-Type Filter Elements

for high-temperature hydraulic and pneumatic line filtration

Poroloy (left) and Poromesh (right) stainless-steel, sintered porous-wire-cloth and porous-wire-mesh disc-type filter elements provide controlled pore size for high-temperature hydraulic and pneumatic line filtration. Elements are available

in eight pore sizes from 5 to 250 mu. Poromesh elements have high flow rates, low pressure drop, and high dirt capacity. Poroloy elements have high strength which permits them to withstand high line-pressure surges without failure. Both elements can be installed with gaskets, snap rings, staking methods, press fits, silver solder, welding, or with epoxy resins. Poroloy elements are made in 25 diameters from 0.0670 to 1.2344 in. and in three standard thicknesses. Poro-



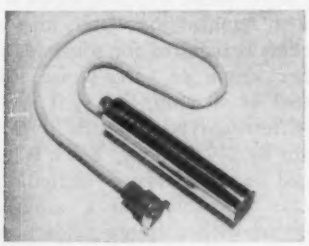
mesh units are available in five standard diameters from 0.375 to 1.368 in. in three standard thicknesses. **Bendix Filter Div., Bendix Aviation Corp.**, 434 W. 12 Mile Rd., Madison Hts., Mich. H

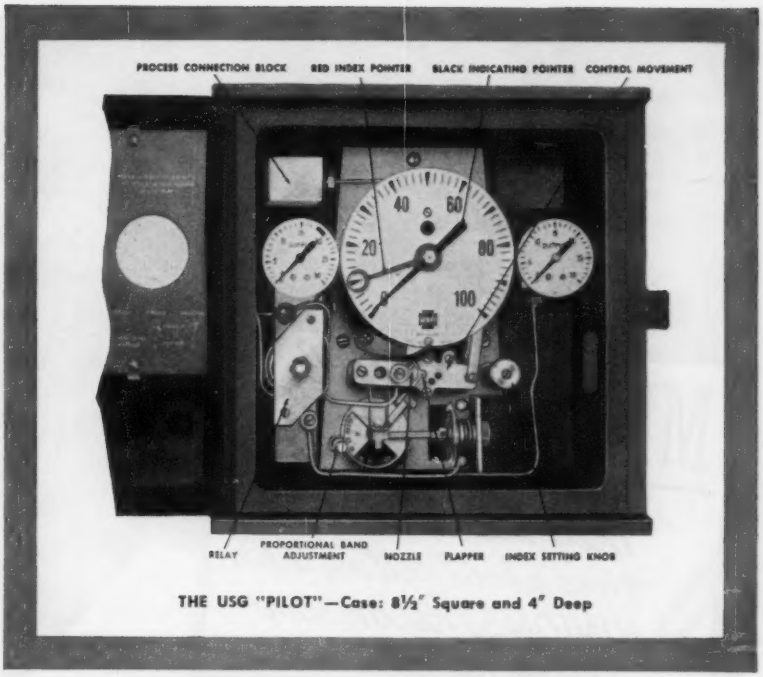
Circle 716 on Page 19

Metal-Sensing Switch

solid-state unit is self-contained

Proxor is a self-contained, solid-state switch only ¾ in. in diam and 4 in. long. Sensing coils, bridge, transistor oscillator, two-stage transistor switch, and miniature printed-circuit board are all encapsulated in chrome-plated case. Switch is triggered by metal in the proximity of a sensing coil. Potentiometer control at rear of instrument provides easy adjustment of sensing zone, facilitating installation. Unit distinguishes between magnetic and nonmagnetic metals, furnishes voltage steps at low rates down to standstill, and requires no electrical contact with workpieces. Uses include counting, feed control, indexing, and overtravel alarm. Unit op-





THE USG "PILOT"—Case: 8½" Square and 4" Deep

A COMPACT, LOW-COST*

INDICATING PNEUMATIC CONTROLLER

for pressure . . . temperature . . . other variables

(1) Control modes to suit your process: Two-position with differential gap (1 to 100%) . . . proportional (1 to 150%), alone or with automatic reset or rate action. Control mode or control action (direct or reverse) easily altered in field.

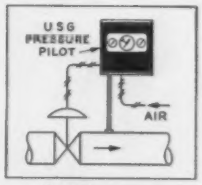
(2) Variable and set point both indicated on large dial: Black pointer indicates reading on 3½-inch dial (6¾-inch scale length). Red circle-tipped pointer spots location of set point.

(3) High accuracy and sensitivity at low cost: Accuracy of 1% of range over middle half of scale. Sensitivity less than 0.1% of scale at 100% proportional band setting . . . compares favorably with higher-priced controllers.

(4) Simplified maintenance and repair: Precalibrated measuring element can be removed for range change. Other basic components, even entire control chassis, can be removed for easy maintenance.

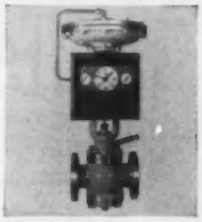
(5) Controls a broad range of variables: Pressures from 30" Hg vacuum to 10,000 psi. Temperatures from —350 F to + 1000 F. Can be adapted to control many other variables, including liquid level.

**Sample price: $126.00 for unit with 316 S.S. Bourdon tube, range 0-600 psi, proportional control 1-100%.*



Typical pressure reducing service

Can be panel or surface mounted



Can be valve mounted

Find Your Nearest Distributor In The 'Yellow Pages'

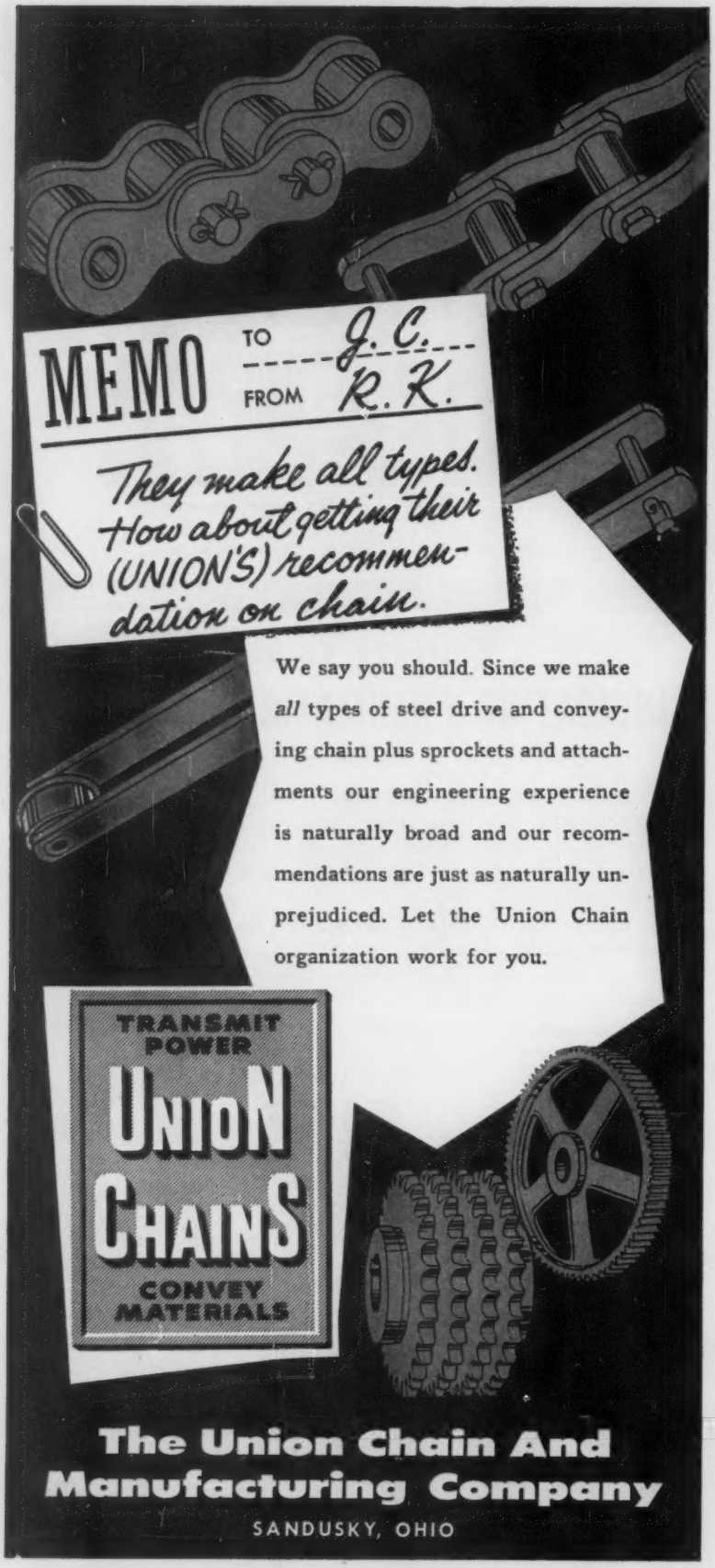
Write for Catalog 510 . . . Gives complete specifications and description of the USG Pilot as well as pneumatic transmitters and receivers for process instrumentation. Send for your copy today, or contact your nearest USG distributor.

UNITED STATES GAUGE

DIVISION OF AMERICAN MACHINE AND METALS, INC., SELLERSVILLE, PA.

USG

Circle 532 on Page 19


MEMO
TO J. C.
FROM R. K.
They make all types. How about getting their (UNION'S) recommendation on chain.
We say you should. Since we make all types of steel drive and conveying chain plus sprockets and attachments our engineering experience is naturally broad and our recommendations are just as naturally unprejudiced. Let the Union Chain organization work for you.
TRANSMIT POWER
UNION CHAINS
CONVEY MATERIALS
The Union Chain And Manufacturing Company
SANDUSKY, OHIO

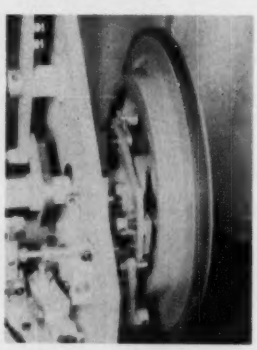
erates at counts to 7200 per minute, and is available in two models for magnetic and nonmagnetic metals. Operating temperature is 0 to 150 F. **Parametrics**, P. O. Box 629, Costa Mesa, Calif. L

Circle 717 on Page 19

Single-Revolution Clutch

has adjustable torque control

New single-revolution clutch, designed to provide automatic, positive rotation on a shaft from a continuously rotating source of power, is equipped with adjustable torque control. Ball-bearing equipped flywheel can be used with V-belt, gear, or direct drive, and permits simplified mounting either at end or in the middle of a shaft. The expanding brake-shoe type clutch features a positive positioning device at dis-



engagement and can be used for clockwise or counterclockwise rotation. Rated at 1/3 hp at 100 rpm, it is for use at speeds up to 150 rpm. Standard shaft size is $\frac{3}{4}$ in., with others available from $\frac{1}{2}$ to 1 in. diam. **Theodore M. Wright Inc.**, Dept. G, P. O. Box 286, Camden 1, N. J. E

Circle 718 on Page 19

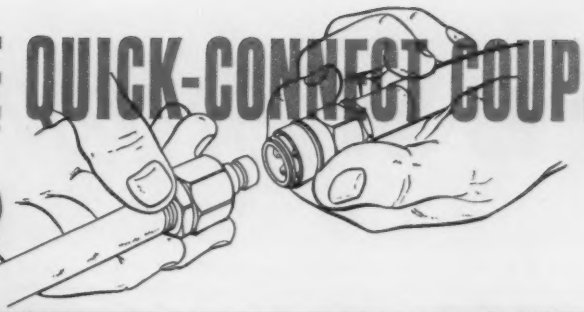
Sectional Terminal Block

accepts ferrule-type fuse 1½ in. long, 13/32 in. diam

Type H fusible terminal block is for use in applications where fuse protection is required for solenoids and other single or three-phase loads. Rated at 30 amp, 600 v, it accepts any ferrule-type fuse 13/32 in. in diam by 1½ in. long. Block is composed of individual sectionalized blocks assembled on a mounting channel with a clamp at each end.

Circle 533 on Page 19

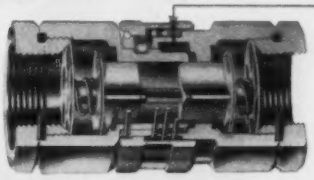
WHICH SNAP-TITE QUICK-CONNECT COUPLING IS BEST FOR YOU?



SNAP-TITE "H" COUPLING . . . . FOR HIGH PRESSURE APPLICATIONS

FOR HYDRAULIC OR AIR

"H" Coupling for high strength, higher efficiency, high-resistance to heavy line surge. Sizes: ⅛" thru 10". Bulletin No. 240

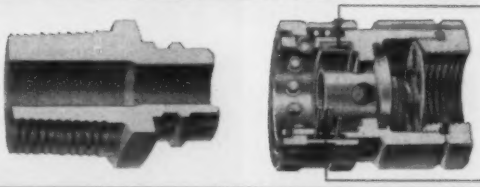


Exclusive U-packer gives a positive seal without compression set because of rubber distortion. Line pressure inside the U-packer keeps it open and forced against its metal backing—the higher the pressure, the tighter the seal.

SNAP-TITE 'IH' COUPLING . . . . FOR IMPACT IN AIR LINES

FOR RESISTING THE IMPACT OF RECIPROCATING AIR OPERATED TOOLS

The 'IH' Coupling delivers more air to tools. Cylinder-type 'IH' valve for 360° contact. Sizes ⅜" thru ½". Bulletin No. 248.



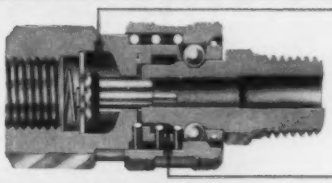
Exclusive U-Packer

360° contact

SNAP-TITE HI-FLOW COUPLING . . . FOR LOW PRESSURE APPLICATIONS

FOR AIR AND FLUIDS UP TO 150 p.s.i.

Hi-Flow is recommended to connect small air tools to plant air system, and for low pressure fluid transfer in small lines. Sizes: ⅛" thru ⅜" Bulletin No. 249



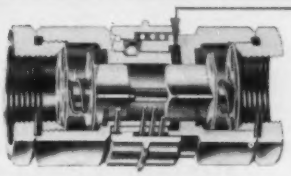
Bonded valve washer (pat. pending on valve construction)

Exclusive U-packer

SNAP-TITE "E" COUPLING . . . . FOR VACUUM and VERY LOW PRESSURE

FOR VACUUM SYSTEMS IN THE MICRON RANGE

"E" Coupling performs in the *micron* range in the smaller sizes both connected and disconnected. Recommended, too, for gravity flow . . . U.L. approved for LP Gas. Sizes: ⅛" thru 10". Bulletin No. 250

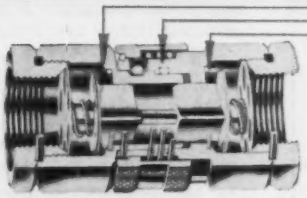


Nipple seals in coupler by depressing the lip of the E packer and slightly compressing the body of the packer. This new E-packer gives positive seal under high-pressure, low-pressure, and vacuum.

SNAP-TITE 'T' COUPLING . . . . . FOR HARD TO HANDLE FLUIDS

FOR FUMING ACIDS, ALKALIES, SOLVENTS . . .

'T' is the only coupling now on the market for fluid temperatures from −40°F to +400°F. Its seals are made of Teflon for which there is no known solvent. Sizes: ½" thru 3". Bulletin No. 270.



Teflon Valve Seal

Teflon Nipple Seal

Teflon Valve Seal

Snap-Tite Couplings are available plain, (without valves), and with either single or double shut-off. Couplings normally furnished in alloy steel, but all (except hi-flow) are also available in brass, aluminum, or stainless steel with a variety of finishes.

SNAP-TITE, INC., UNION CITY 11, PA.

★ Snap-tite

SNAP-TITE COUPLINGS CAN HANDLE ALMOST ANYTHING THAT FLOWS

Circle 534 on Page 19

R B&W FASTENER BRIEFS

RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

Technical-ities

By John S. Davey

The strength of nuts

With a hard, heat treated nut, ability to plastically adjust and distribute load over many threads diminishes. High loads tend to concentrate on first thread severely enough to cause stripping . . . or fracture of first thread, which causes locking. Nut then cannot increase tension in bolt.

Untreated nuts are strong enough for most needs, and don't pose this problem.

A CAUSE OF STRIPPING

Upon tightening, a nut both compresses and dilates. Dilation can be overcome by wall thickness only, not by added height or heat treatment.

Dilation is important since a reduction in area of bolt under tension accompanies it. Threads pull away from each other, from their stronger base to weaker tips. The shallowness of *fine* threads can cause progressive shear.

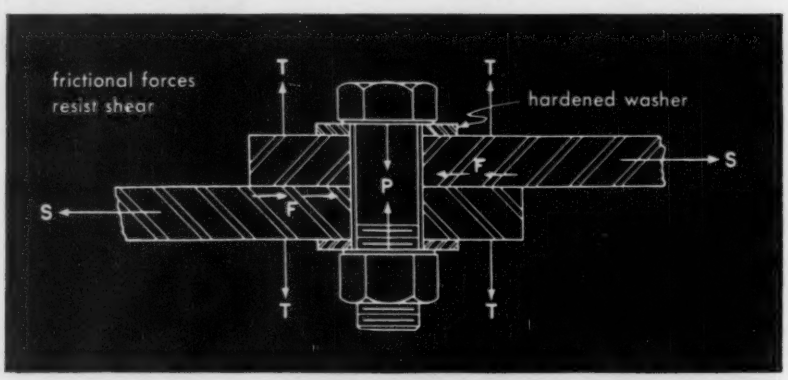
That's why High Nuts (with fine threads) are no answer where "Heavy" Nuts (with coarse threads) are.

WRENCHING STRESS HIGHEST

Rotation of nut produces both tension and torsion in bolt. The force applying this combined stress is about 20% greater than the load which must be sustained when rotation stops.

Thus . . . if a nut hasn't failed in wrenching, it can still withstand at least 20% more direct pull than it sustained during the tightening.

Why high strength bolts make superior joint for dynamic loads



Washers prevent crushing under head and nut with consequent grip relaxation.

While fasteners must be strong enough to carry the calculated loads, what makes a *joint* truly strong is the *residual tension* after wrenching.

NO SLIP OR SEPARATION

Consider the simple lap joint in sketch. Practically rigid, this joint is subjected only to: (1) external tension forces "T" tending to separate the plates against bolt clamping force "P"; (2) shear forces "S" tending to make plates slip against friction resistance "F".

"F" increases when "P" does. With enough clamping force applied, shear loads transfer from one plate to the other without slippage. And when clamping force always exceeds tensile forces, plates obviously *cannot* separate. There can be no further stretch on bolt. Its load stays static at preload "P", even when external loads are dynamic.

UNIFORM CONTROL OF PERFORMANCE

RB&W high strength bolts allow a high magnitude of clamping force to be applied . . . and *uniformly* so. Materials conform to ASTM specifications. Applying known torques to nut produces uniform bolt tensions. Riveting by contrast, depends on difficult-to-control variables.

MORE STRENGTH OVERALL

For shear-resistance, riveted joints offer only the actual rivet shear strength. Don't count too much on friction even though rivets exert some grip as they cool. Compare: a 1-inch bolt tightens to a tension of 42,000 lbs; a 1-inch rivet develops 22,000 lbs at best.

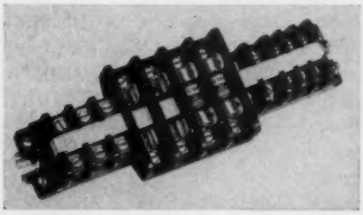
The higher residual tension does more than make a joint much stronger in shear and in tension. It also protects the bolt against fatigue caused by stress-reversing cycles such as vibration; keeps the bolt from loosening, too.

All this explains why, under heavy dynamic loads, rivets can loosen, elongate holes, often fail, requiring difficult replacement; but high strength bolts stand up. They can keep connections permanently tight on vibrating machinery, heavy duty conveyors, and transportation equipment.

Talk it over with an RB&W fastener expert. Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N. Y.

RB&W high strength bolts are from selected grade of medium carbon steel with proper combination of ductility and tensile strength; conform to ASTM A325.

Plants at: Port Chester, N.Y.; Coraopolis, Pa.; Rock Falls, Ill.; Los Angeles, Calif. Additional sales offices at: Ardmore (Phila.), Pa.; Pittsburgh; Detroit; Chicago; Dallas; San Francisco.



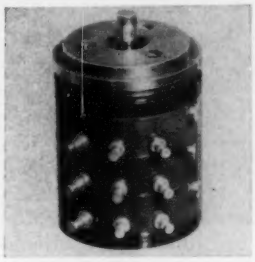
It can be combined with four types of terminal blocks for increased flexibility. **Square D Co.**, 4041 N. Richards St., Milwaukee 12, Wis. K

Circle 719 on Page 19

Gang-Type Potentiometer

has cups which can be phased individually after installation

Model 319 gang-type potentiometer is designed to make possible the phasing and rephasing of individual resistance wipers without disturbing resistance settings of adjacent cups, saving calibration and phasing time. Design also permits nonlinear and sine-cosine functions. Potentiometer case is high-temperature plastic, and mounts and ends are stainless steel. Unit is available in resistance values up to 200,000 ohms with 0.05 linearity. Power output is 2 w. Potentiometer meets all applicable MIL-E-5272A and MIL-STD-200 requirements. **Potentiometer Div., Daystrom Pacific,** 9320 Lincoln Blvd., Los Angeles 45, Calif. L



Circle 720 on Page 19

Solenoid Valves

are explosionproof and splashproof

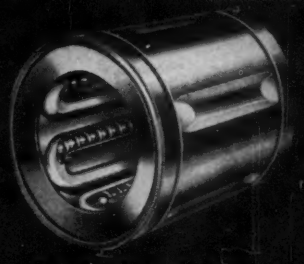
Normally open and normally closed valves for automatic or remote control of flow of water, brine, oil, solvents, gas, and air are explosionproof and splashproof units. Some of the valves are for specific hydraulic control applications and others for specific control of air or

NOW! *Adjustable Diameter and Open* THOMSON

BALL BUSHINGS

Adjustable Diameter BALL BUSHING for Zero Clearance

The BALL Bearing for *all* your **LINEAR MOTIONS**



Precision Series "A" and Low Cost Series "B" BALL BUSHING

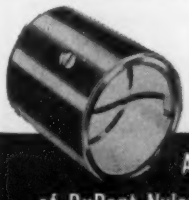
Open BALL BUSHING for Zero Clearance on Supported Shafts

Sliding linear motions are nearly always troublesome. Thousands of progressive engineers and designers have solved this problem by application of BALL BUSHINGS on *guide rods, reciprocating shafts, push-pull actions,* or for support of *any mechanism that is moved or shifted in a straight line.*

Improve your product! Up-date your design and performance with Thomson BALL BUSHINGS!

LOW FRICTION • ZERO SHAKE OR PLAY
ELIMINATE BINDING AND CHATTER
SOLVE SLIDING LUBRICATION PROBLEMS
LONG LIFE • LASTING ALIGNMENT

The various types cover a shaft diameter range of ¼" to 4". Small sizes available in Stainless Steel. Write for literature and name of our representative in your city.



THOMSON INDUSTRIES, Inc.
Dept. E, MANHASSET, NEW YORK

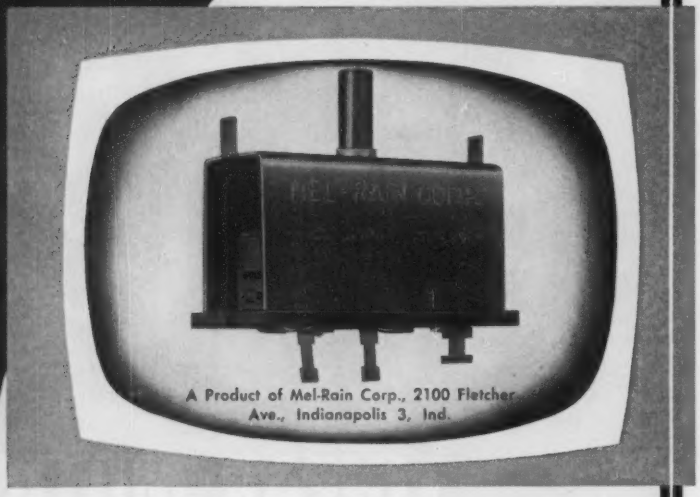
Circle 536 on Page 19

Also Manufacturers of NYLINED Bearings . . . Sleeve Bearings of DuPont Nylon, and 60 CASE . . . Hardened and Ground Steel Shafting

Chace Thermostatic Bimetal

ACTUATES ANOTHER PRECISION PRODUCT . . .

THE MEL-RAIN TV CIRCUIT PROTECTOR



A Product of Mel-Rain Corp., 2100 Fletcher Ave., Indianapolis 3, Ind.

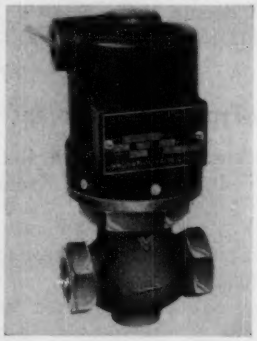
While all will agree that TV circuits need protection against malfunctioning, especially for conditions which could start fires, the nuisance and high cost of fuse replacement by a service man is abominated by all. Mel-Rain Corporation has licked this problem with their line of TV Circuit Protectors. They make the set inoperative in case a hazardous condition exists but, since a high percentage of failures is due to ageing or intermittent surges, the set may be put into use immediately by simply resetting the button. The Mel-Rain design also prevents "cycling" and sticking of contacts, and the breaking of the circuit by high ambient temperatures both in the set and in the room. The units are low-cost, reliable and handle a current range from 100 MA to 7½ amperes in a temperature spread up to 150°.

Here is a case where *reliability* in the protective device must be obtained at low cost, as competition is severe among TV manufacturers. Known for a third of a century for its dependability and precision, Chace Thermostatic Bimetal is also far and away the best *buy* in bimetal. The quality which results from Chace's processes reduces rejects to an almost incalculable fraction of a percentage point, an indication of the skill of our manufacturing and the thoroughness of our development, testing, and inspection methods. Final proof, of course, is the satisfaction which products actuated by Chace bimetal give to their owners, year after year.

When your temperature responsive device approaches the design stage, remember these qualities of over 30 types of Chace Thermostatic Bimetal, whether in strip, coil or completely fabricated elements of your design. Send for our new booklet, "Successful Applications of Chace Thermostatic Bimetal," containing many pages of design data.

W. M. CHACE CO.
Thermostatic Bimetal
1616 BEARD AVE., DETROIT 9, MICH.

gases under pressure or vacuum, and also water or other liquids of various viscosities not injurious to bronze. Control circuits include flow of liquid-level control, push-button, pressure switch, limit control, thermostat, and electronic relays. Valves handle fluid temperatures up to 212 F and pressures up to 300 psi. They are available for



nominal pipe sizes of ¼ to 3 in. **Magnatrol Valve Corp.**, Fifth Avenue, Hawthorne, N. J. D

Circle 721 on Page 19

Thermal Insulation

for temperatures to 2200 F

Fibrous potassium titanate is composed of a compact mass of lightweight crystalline fibers having small diameter and high reflectance. Material blocks heat penetration by scattering incoming infrared rays. It is suited for applications where space and weight are critical, and is particularly effective in 1300 to 2100-F range. Applications include use in airborne equipment, insulation, reflective shielding, gaskets and packing, filters, and high-temperature paints or coatings. Material is easily fabricated, and is available in loose fibers, loose fill, blocks of varying densities, mats of various thicknesses, lumps, and in a trowelable form. **E. I. duPont de Nemours & Co. Inc.**, Wilmington 98, Del. C

Circle 722 on Page 19

Rotation Joint

withstands temperatures from − 55 to 735 F

Lightweight and corrosion resistant, new rotation joint has low leakage rate, full 360-deg rotation, and low breakaway torque. Used between

Circle 537 on Page 19

chances are you'll find Caplugs ideal for your closure needs, too . . . they're made of tough, flexible Polyethylene . . . easy to apply and a cinch to remove . . . won't chip, break, shred or collapse . . . over 500 sizes in a dozen different styles now on the shelf.

Caplugs

QUICK, SLICK PROTECTION FOR PRODUCTS IN PROCESS, STORAGE AND TRANSIT

Circle 538 on Page 19

GET THIS KIT FULL OF SAMPLES IN EXCHANGE FOR THE COUPON ATTACHED

CAPLUGS DIVISION, PROTECTIVE CLOSURES CO., INC.
2201 Elmwood Ave., Buffalo 23, N.Y.

Mail a free assortment of Caplugs, literature and prices to us, without obligation.

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FIRM _____

ADDRESS _____

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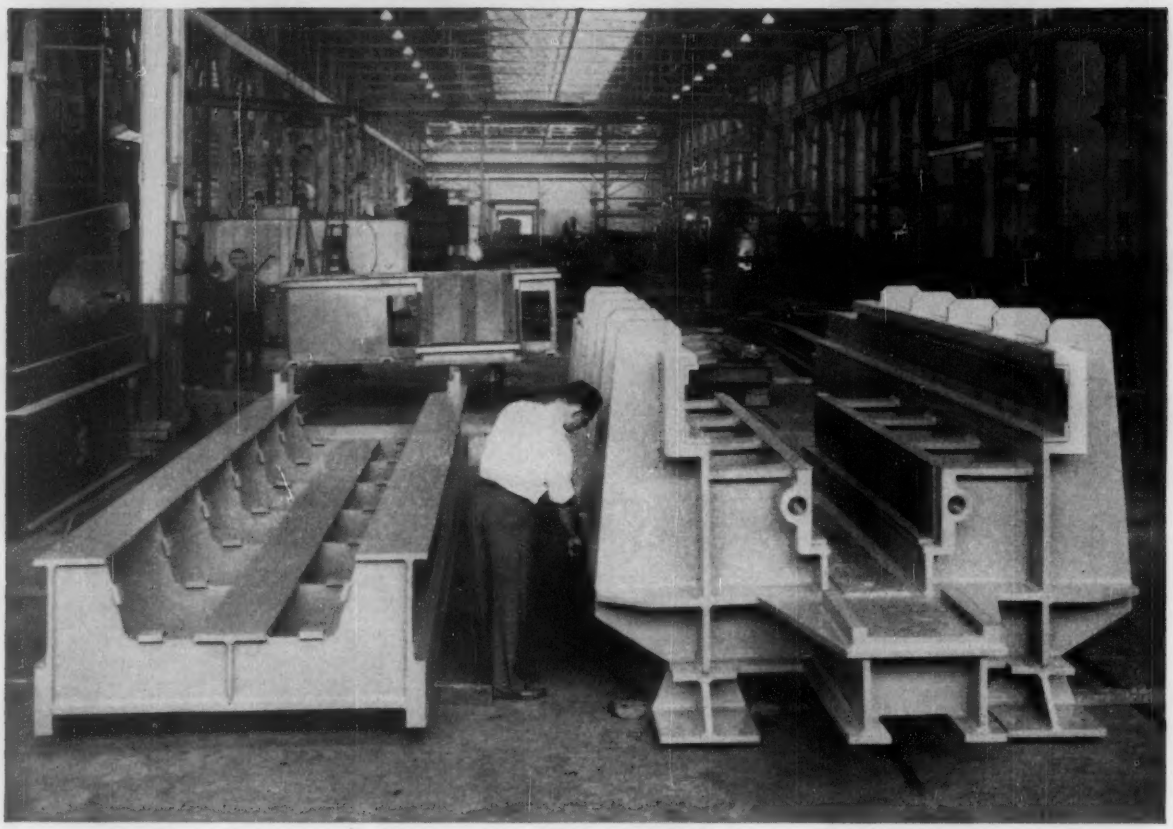
STEEL-WELD FABRICATION . . .



Will Save TIME and MONEY in the Construction of Virtually Any Big Piece of Machinery!

The 40-Ton Frame and Carriage, illustrated above, are Steel-Weld Fabricated Parts of a loading device for a large extrusion press. These weldments are typical of thousands of Steel-Weld Fabricated units produced by Mahon for manufacturers of processing machinery, machine tools, and other types of heavy mechanical equipment.

When your design calls for weldments of any kind, you, too, will want to discuss your requirements with Mahon engineers; because, in the Mahon Company you will find a unique source for weldments or welded steel in any form . . . a fully responsible source with a long and enviable performance record, and unusual facilities for design engineering, fabricating, machining and assembling.

See Sweet's Product Design File for information, or have a Mahon sales engineer call at your convenience.

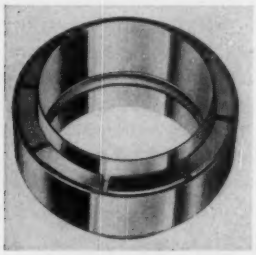
Use WELDED STEEL for 100% Predictability and Greater Strength with Reduced Weight!

THE R. C. MAHON COMPANY • Detroit 34, Michigan

SALES-ENGINEERING OFFICES in DETROIT, NEW YORK and CHICAGO

MAHON

Circle 539 on Page 19



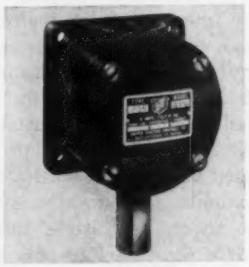
sections or systems which are hinged or rotate about each other, it withstands pressures up to 390 psi and temperatures from −55 to 735 F. Joint is for use wherever ram or bleed air must be transferred between hinged or rotated sections, particularly in airborne applications such as boundary-layer control ducting, cabin pressure systems, anti-icing systems, missile-launching racks, and dehumidifying systems for cameras and instrumentation. Use of a double-thrust bearing enables joint to withstand axial tension and compression loads in addition to pressure loads. **Marman Div., Aeroquip Corp.**, 11214 Exposition Blvd., Los Angeles 64, Calif. L

Circle 723 on Page 19

Pressure-Vacuum Control

for pressures to 600 psi

Type J95 pressure-vacuum control is designed for use in hazardous locations where explosive gases or vapors are present. This is an uncalibrated unit, and pressure settings are made by an internal adjusting nut. Models are available with a variety of adjustable ranges between 0 and 500 psi, and with maximum pressures up to 600 psi. Cast-iron enclosure permits use of the control in Class I, Groups C and D, Class II, Groups E, F, and G, and in Class III applications as defined by the National Electric Code. Many types of switches are available, including normally open, normally



Stearns MODEL GS
CLUTCH
NEW HIGH TORQUES —
SAME SMALL SIZES
Sets new standards of reliability and maintenance convenience

Min. Diameter 4 1/2 in.
Max. Diameter 9 1/4 in.
Min. Depth - - 3 1/2 in.
Max. Depth - - - 6 in.

NEW Torque Ranges —
Dry — 12 to 1260 lb ft; Wet (oil) — 16 to 1140 lb ft.
(former ratings from 9 to 540 lb ft.)

NEW Stearns Friction Discs —
provide long, trouble-free life — greater resistance to heat and pressure . . . seldom need adjustment for wear. Type "GS" friction discs can be replaced, or adjusted quickly and easily with just a screwdriver as your tool kit . . . for lowest-cost-per-year operation . . . specify Stearns!

✓ Check — Compare these additional Savings features:
- Stationary Magnet Body — simplifies installation. No thrust loads on shafts or machine elements. All clamping forces are self-contained.
- Plug-in Electrical Connections — No slip-rings, no brushes to install or maintain.
- Shipped Fully Assembled — you receive units from Stearns completely assembled, tested, ready for installation.
- Duplexed Bearings—conservatively loaded, sealed, prelubricated... assures longer, trouble-free life.
- Versatile Control — can be electrically energized by virtually any type switching device of adequate capacity.

Call your local Stearns Representative, or write direct for complete "GS" data.

For Superior Performance . . . Specify Stearns!

Stearns ELECTRIC CORPORATION
120 NORTH BROADWAY
MILWAUKEE 2, WISCONSIN

Circle 540 on Page 19

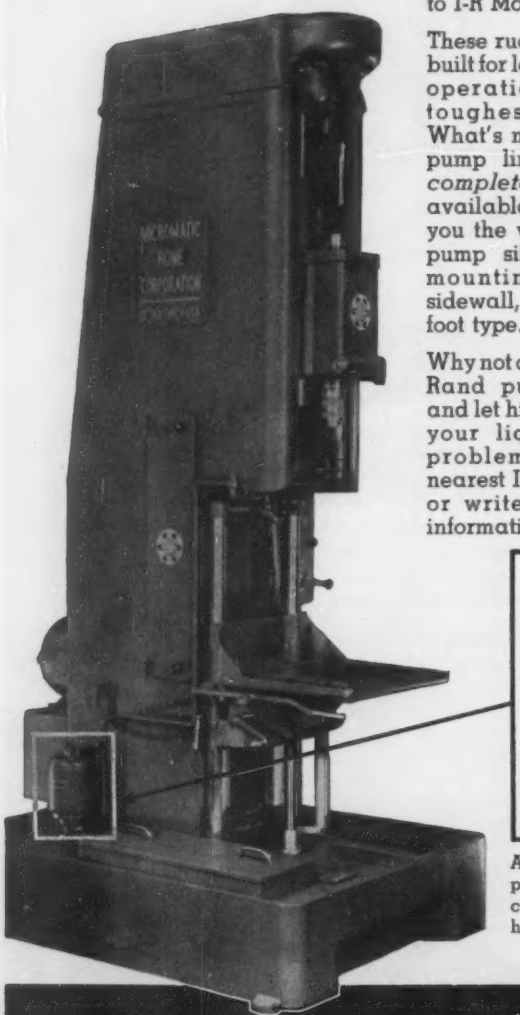
versatile

pumping power

with dependable

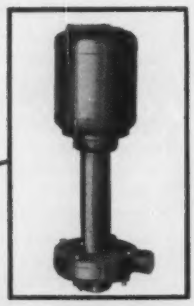
MOTORPUMPS

The efficient handling of coolant, cutting oils and washing liquids in modern production equipment calls for maximum pumping efficiency. And to solve the various problems in all types of equipment, designers today look *first* to I-R Motorpumps.



These rugged pumps are built for long, trouble-free operation under the toughest conditions. What's more, the Motorpump line is the most *complete* line of pumps available today, offering you the widest choice of pump sizes, types and mountings including sidewall, immersion or foot type.

Why not call an Ingersoll-Rand pump specialist and let him help you with your liquid handling problems. Call your nearest I-R branch office or write for complete information.



An immersion type Motorpump handles abrasive coolant on a modern honing machine.

9-820

Ingersoll-Rand / 11 Broadway, New York 4, N. Y.

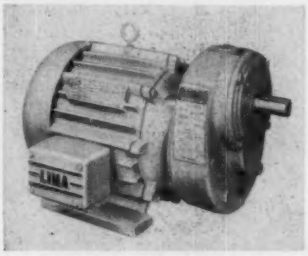
closed, or double throw with no neutral position. They are rated for 15 amp at 115 or 230 v ac. All switches are single pole and suitable for 180-F ambient temperature. **United Electric Controls Co.**, 79 School St., Watertown 72, Mass. B

Circle 724 on Page 19

Gear Motors

with motor capacities from 1 to 125 hp

New line of gear motors consists of single, double, and triple-reduction units, integrally motor mounted, with lifetime gearing. Motor capacities range from 1 to 125 hp, with output reduction speeds from 780 to 7½ rpm. Units are adapted for horizontal foot-mounted applications, and are available in open drip-proof, totally enclosed fan-



cooled, and explosionproof construction. Standard electrical characteristics are: normal torque; three or two phase; 60 cycle; 208, 220/440, or 550 v. **Lima Electric Motor Co. Inc.**, Dept. 139, Lima, Ohio. G

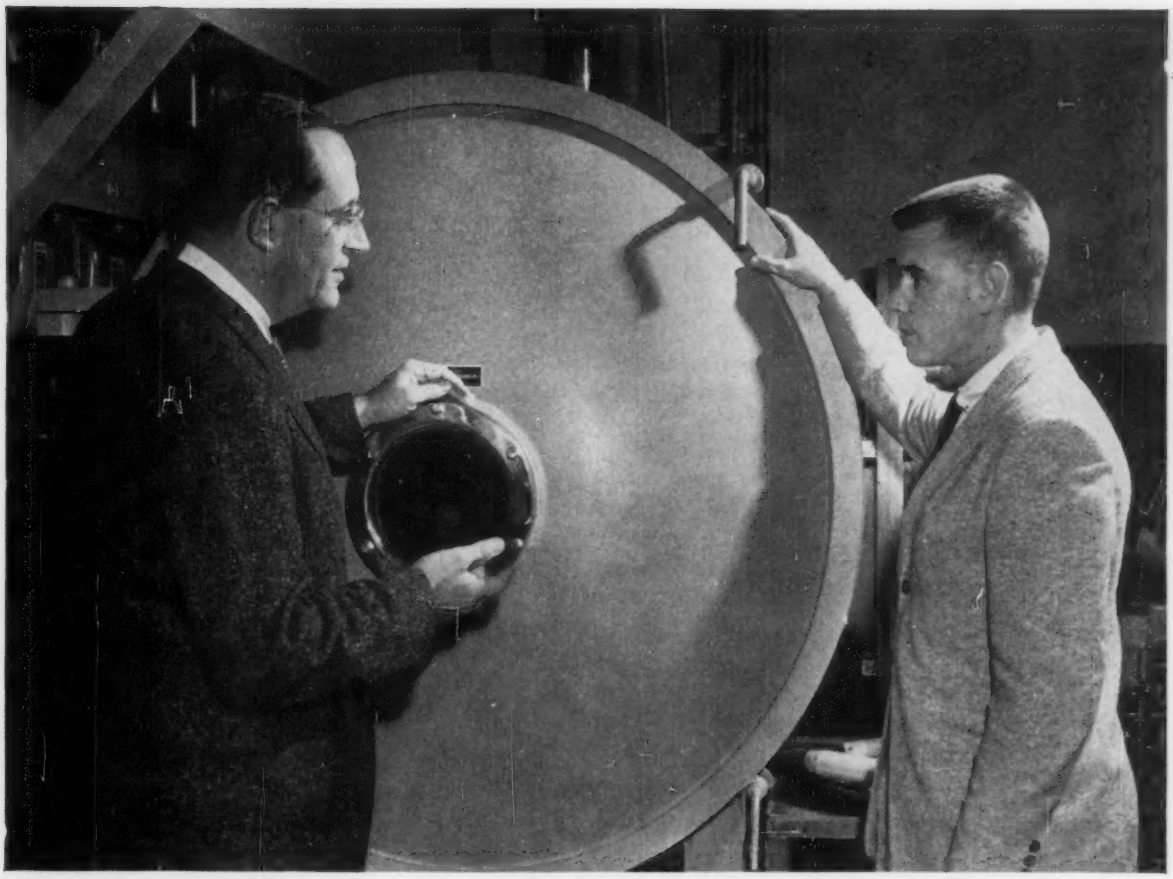
Circle 725 on Page 19

Pushbutton Switch

oiltight unit saves space on control panels

Pushbutton switch is designed for critical space requirements on control and console panels or pendant stations needing splash protection. Subminiature switch with double-break contacts is rated at 10 amp, 125, 250 v ac, or 30 v dc inductive. Button mechanism is sealed with oil and coolant-resistant neoprene. Integral O-ring seals bushing to panel, and squeeze tabs on switch bracket permit easy installation. Switch is quickly clipped to panel-mounted button after wiring. Switch is available in four standard terminal styles, each style furnished in single through four-pole assem-

Circle 541 on Page 19



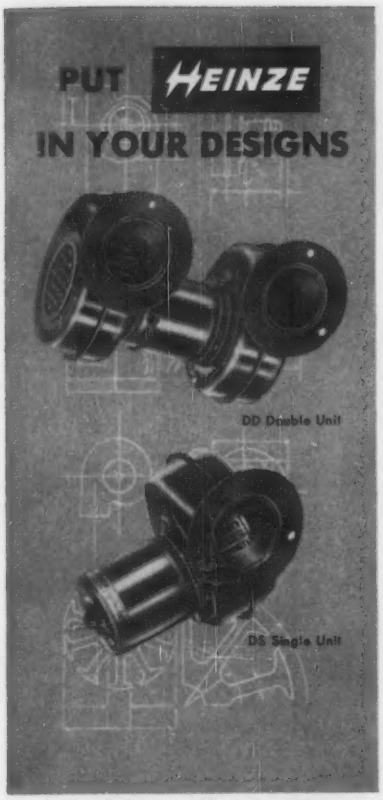
Top-ranking engineer giving a promising newcomer some practical information about one of AC's high altitude pressure chambers.

How far can an engineer go at AC?

Inertial Guidance Systems • Afterburner Fuel Controls • Bombing Navigational Computers • Gun-Bomb-Rocket Sights • Gyro-Accelerometers • Gyroscopes • Torquemeters • Speed Sensitive Switches and Sensors • Vibracall • Skyphone

That depends on your aspirations. Do you want long-range security? Diverse assignments? Professional status? Intriguing location? A top management position? It's possible to find all of them at AC—the Electronics Division of General Motors. One thing is sure—if you are a graduate engineer in the electronic, electrical or mechanical fields—*you can go places at AC, because AC is going places.* AC is in the instrumentation business. And there are virtually no limits to the projects and problems—both military and commercial—to which AC can apply its top-flight personnel and world-wide facilities. Today AC builds the AChiever—inertial guidance system for some of the world's leading missiles—plus a wide variety of other electro-mechanical, optical and infra-red devices. Tomorrow AC may build inertial systems for commercial aircraft and ships at sea as well as automotive electronic components. This is the kind of opportunity you should look into—today. Just write the Director of Scientific and Professional Employment: Mr. Robert Allen, Oak Creek Plant, Dept. C, Box 746, South Milwaukee, Wisconsin; or Mr. M. Levett, Dept. C, 1300 N. Dort Highway, Flint 2, Michigan. It may be the most important letter of your life.

AC SPARK PLUG ⚛ THE ELECTRONICS DIVISION OF GENERAL MOTORS



TYPE D BLOWERS

long life
simple maintenance

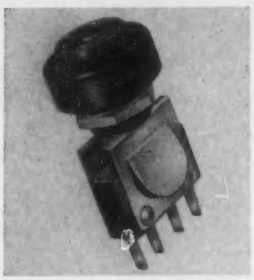
Single or double blowers, with durable metal housing, are powered by type D shaded pole induction motor. Rugged units require little oiling, won't interfere with radio or TV. Standard operation is on 115 V, 60 cycles, AC. Single unit has load speed of 3200 rpm, 55 cfm; double unit operates at 3100 rpm, 100 cfm. Other frequencies and voltages available.

Heinze Blowers are designed to your exact specifications — for vending machines, photo dark rooms, laboratories, kitchens, refrigerators, air conditioning units, furnace draft boosters, animated displays, cooling electronic equipment, and other general cooling applications. Write for new catalog to Department D.

HEINZE ELECTRIC COMPANY
685 Lawrence St., Lowell, Mass.

SUB-FRACTIONAL HORSEPOWER MOTORS AND BLOWERS

Circle 543 on Page 19



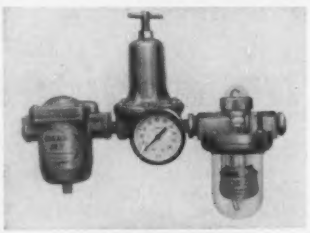
blies for multiple circuitry. **Licon Switch & Control Div., Illinois Tool Works,** 6606 W. Dakin St., Chicago 34, Ill. J

Circle 726 on Page 19

Filter-Regulator-Lubricator

accommodates air-line pressures to 250 psi

New combination filter-regulator-lubricator is available for ¼, ⅜, and ½-in. pipe, and accommodates air-line pressures to 250 psi. Air flow at 90 psi varies from 20 to 70 cfm. In the lubricator, acceleration of air passing through a venturi forms oil mist, permitting easy adjustment for both high and low-volume air supply. Pressure regulator adjusts and maintains desired air pressure without materially re-



ducing flow, because of oversized air passages and diaphragm chamber separated from air passage. Both automatic and manual air filters are available. **Mead Specialties Co.,** Dept. R-25, 4114 N. Knox Ave., Chicago 41, Ill. J

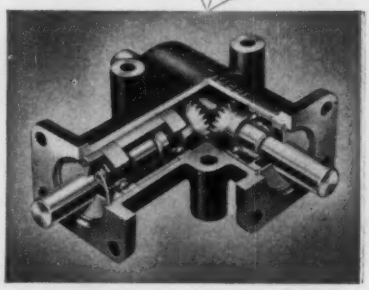
Circle 727 on Page 19

Miniature Magnetic Clutches

control servo system rotary mechanical functions

Miniature magnetic clutches are available in two lightweight models for electrical control of servo system rotary mechanical functions. Model 583 is especially suited for small-space applications, since it is only 1¼ in. in diam and 2-11/16

NEW 2¼ HP ANGLgear® HELPS SIMPLIFY YOUR 90° DRIVE PROBLEMS



Hardened bevel gears and antifriction bearings insure smooth, trouble-free operation. Completely enclosed, permanently lubricated ANGLgear requires little or no maintenance.

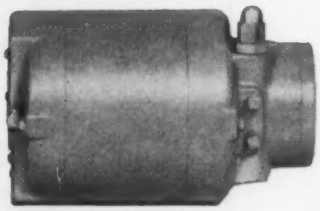
Addition of the new 2¼ hp size to the ANGLgear line makes it easier than ever to solve your 90° power takeoff problems with this standardized right-angle drive. You can now specify ANGLgear in any one of 16 different stock models, offering power ratings from ⅛ to 5 hp, with choice of 1:1 or 2:1 gearing and 2 or 3-way shafting.

Compact, high capacity ANGLgear offers you several distinct advantages over V-belts or chains and sprockets. Featuring 5-way mounting, it is easier to design into your power transmission systems. Incorporating positive bevel gear drive, it eliminates slippage and backlash problems. Completely enclosed, it presents no safety hazards. Permanently lubricated, it requires virtually no maintenance. And not the least important, ANGLgear invariably costs less than other types of 90° drives.

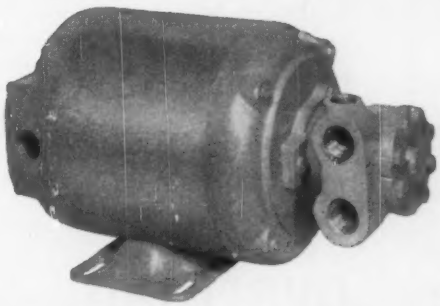
See our literature in Sweet's Product Design File or contact your local distributor.

AIRBORNE®
AIRBORNE ACCESSORIES CORPORATION
HILLSIDE 5, NEW JERSEY

Circle 544 on Page 19

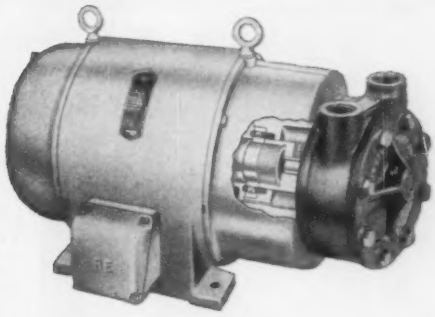


1



2

3 NEW TUTHILL close coupled pump and motor units



3

Save space, Save weight, Cut costs

Now TUTHILL offers three pump and motor combinations developed specifically for applications where space or weight are at a premium. Furnished in a wide variety of sizes and styles, one of these combinations can provide savings in hydraulic, oil burning, lubrication or other services.

The small size of these combinations solves design problems. By reducing weight they cut shipping charges. The elimination of couplings, adapters and bases means lower costs. And even more important savings are often made through the simplification of installation procedures.

Available from Stock

A wide variety of combinations are available immediately from stock, in either large or small quantities.

For example, Number 1 above is TUTHILL'S famous POWERMITE—a combination in which pump and motor are incorporated in one unit which takes up no more space than a standard electric motor (the POWERMITE shown measures only 3⅞" x 7½").

Originally restricted to large quantity applications some POWERMITE models are now available from stock for small quantity orders. The unit shown is rated for 16 GPH at 350 PSI.

For other small quantity applications TUTHILL provides a complete selection of close coupled units with the pump mounted directly on the motor. Numbers 2 and 3 above are typical.

For applications, such as hydraulics which require smaller pumps, units such as Number 2 above provide outstanding advantages. Normally they can reduce space required for pump and motor by at least 6 inches, and cut weight by several pounds. Capacities range from 20 to 300 GPH. Pumps are available for pressures up to 1500 PSI.

Larger pump and motor combinations, such as Number 3 above, can be provided with capacities up to 50 GPM, for pressures up to 400 PSI.

If you are trying to put a pump and motor into a small space, TUTHILL has the answer. Write for details.

Tuthill Manufactures a Complete Line of Positive Displacement Rotary Pumps in Capacities From 1 to 200 GPM; for Pressures to 1500 PSI; Speeds to 3600 RPM.

TUTHILL PUMP COMPANY

953 East 95th Street, Chicago 19, Illinois

PUMPS FOR YOUR PURPOSE

TUTHILL PUMP COMPANY
953 East 95th Street, Chicago 19, Illinois

☐ Please forward complete information on TUTHILL close-coupled Pump and Motor Units for_____GPH at_____PSI.

☐ Please have your representative call.

NAME_____TITLE_____

COMPANY_____

STREET_____

CITY_____

STATE_____

PLUS
protection
against
overload

Maxitorq

overload release clutches

Designers and builders have found MAXITORQ Overload Release Clutches the ideal way to provide dependable protection against overload conditions.

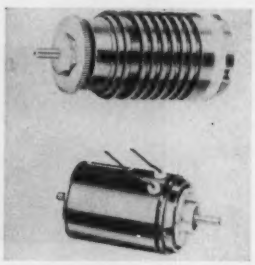
Unlike such devices as shear pins, the MAXITORQ Overload Release Clutch requires no dis-assembly or replacement after functioning. Once the cause of overload is removed or corrected, the machine may be re-started at once. Furthermore, MAXITORQ Overload Release Clutches may be adjusted for pre-determined overload protection.

In addition, users enjoy the proved advantages of the MAXITORQ Floating Disc Clutch . . . smooth, positive engagement and release . . . "floating" neutral with no drag or heating . . . easy manual adjustment.

We will be glad to give you the benefit of our long and successful experience in clutch and brake design; the overload release clutches are only one of many advanced MAXITORQ developments in both manual and electrically operated applications. Ask for literature, or outline your problem . . . write Dept. MD-9.

THE CARLYLE JOHNSON MACHINE CO.
Manchester, Connecticut

2CJ58



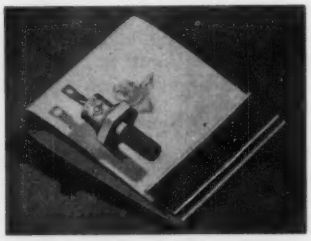
in. long. Model 543 for more rugged duty is 1¾ in. in diam and 4⅛ in. long. Both models are dry-disc, fixed-coil, solenoid-controlled clutches which use no slip rings. Inputs of 24 or 48 v can be specified. A 48-pitch, 14½-deg pressure-angle, stainless-steel input gear is furnished with each clutch. **Helipot Div., Beckman Instruments Inc.,** Fullerton, Calif. L

Circle 728 on Page 19

Silicon Rectifiers

diffused-junction units provide currents to 6 amp

New diffused-junction silicon rectifiers provide currents up to 6 amp over an inverse-voltage range from 50 to 500 v. Units are operable at diode base temperatures up to 150 C. They have all-welded construction which is completely free from flux material. Each unit is nickel plated to provide minimum contact resistance and prevent corrosion. Applications include miniaturized airborne power supplies, electrical



instrument testing, oscilloscopes, and other power-supply requirements. **Industrial Products Dept., International Rectifier Corp.,** El Segundo, Calif. L

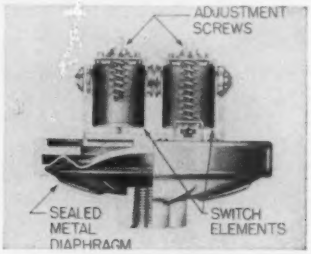
Circle 729 on Page 19

Pressure and Vacuum Switches

can be mounted directly on vibrating or moving equipment

Stripped models of pressure and vacuum switches, designed for OEM

and industrial installations where controls are enclosed in a common cabinet, can be mounted directly on moving or vibrating equipment. Switches, for use in liquid, gas, or water systems, are available in proof pressures of 30 in. Hg vacuum to 150 psi pressure. They sense any two pressures in the same system over adjustable range of 30 in. Hg vacuum to 100 psi pressure, and actuate two independent electric circuits at the predetermined pressures, on both increasing and decreasing pressures. Single



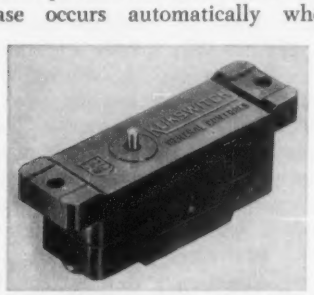
pole, double-throw switching elements for ac and dc circuits are automatically reset by snap action of switches. **Pressure Switch Div., Barksdale Valves,** 5125 Alcoa Ave., Los Angeles, Calif. L

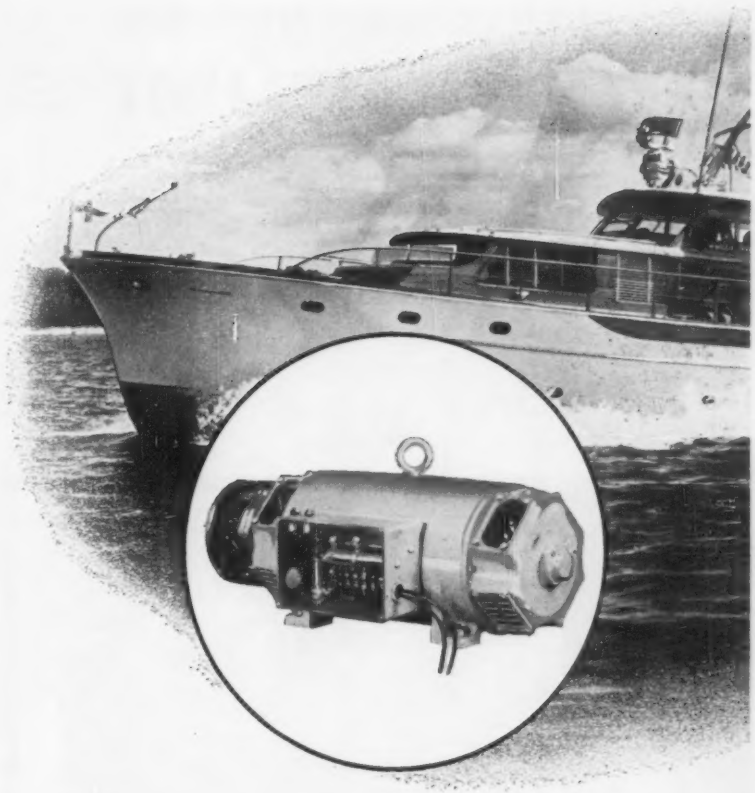
Circle 730 on Page 19

Snap-Action Switch

has integrally molded mounting ears

Rigid mounting on back of panel or other surface in fixed relation to actuating mechanisms is provided by integrally molded mounting ears on basic Klikswitches. Side mounting holes also permit use of mounting ears for attaching various forms of actuating mechanisms. Snap-action switch mechanism is encased in molded phenolic. It is available with SPDT or SPST normally closed contacts rated 8 amp at 115 v ac, noninductive. Operation requires 14.26 oz force, and release occurs automatically when





ESCO alternator powers new ultra-compact high-performance radar

Based on an entirely new concept in radar design, this Raytheon "Mariners Pathfinder" radar is compact enough for use on the most modest pleasure cruiser, yet big enough in performance for the largest commercial vessels. Utilizing just two, simple units, it provides clear, steady displays up to 16 miles range. Rugged and reliable, it's real sea-going equipment, built to operate in slashing northeasters, arctic ice and the heat and humidity of tropic seas.

To provide a source of dependable, stable power for the "Mariners Pathfinder", Raytheon chose a specially-designed ESCO motor-alternator. Operating from a 32V, 110V or 220V DC ship's supply, this built-to-order inverter delivers a 115V 60-cycle AC output, regulated to ±3V and ±0.6 cycles over a 20% variation in input voltage. It's designed for a minimum of 10,000 hours trouble-free operation under extremely wide variations in temperature, humidity, and pitch and roll conditions.

Building special rotating electrical equipment to meet individual requirements has been a specialty at ESCO for almost half a century. Why not call on ESCO for the ideal generator or motor for your equipment, too? *Write for design brochure today.*

ESCO ELECTRIC SPECIALTY CO.
179 South Street, Stamford, Conn.

Circle 547 on Page 19

JAEGER DEPENDS ON

ROPER PUMPS

...so can you

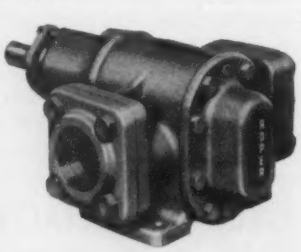
TWO STAGE ROTARY COMPRESSOR COOLED BY ITS OWN LUBRICATING OIL

Typical of Roper adaptability to heavy duty equipment is this installation on the Jaeger Roto Air-Plus, 2-stage rotary compressor. The pump sprays cooled, filtered oil onto the rotor and bearings in high and low compressor cylinders in order to lubricate all surfaces and seal against air leakage. The efficiency of the cooling system insures cool operation in ambient temperatures exceeding 100°. Arrangement of the system is such that oil-free air reaches the air service valve.

The Jaeger compressor has established service records of maintaining 100 lbs. constant pressure for 160 hours, without let-up — a tribute to the unit's dependability, and the Roper that helps cool it.

For OEM... Specify ROPER

In this instance, the Series K pump is suited to the Jaeger application. This series is available in sizes ¾ to 50 GPM, pressures to 150 PSI. It is a rotary gear unit, with sizes 10 through 50 featuring the patented venturi suction and discharge principle for smooth, quiet operation.



ROPER HYDRAULICS, INC.

Send for Bulletins Today

246 BLACKHAWK PARK AVE., ROCKFORD, ILL.

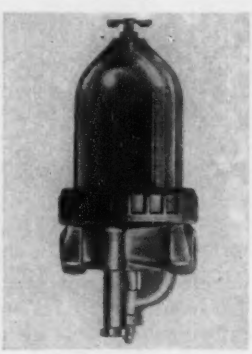
force is reduced to 6.34 oz. Unit is also available with manual release. **Automation Div., General Controls,** 8062 F. McCormick Blvd., Skokie, Ill. J

Circle 731 on Page 19

Air-Line Lubricator

has built-in float mechanism to maintain constant oil level

A606 Perma Fog air-line lubricator features built-in float mechanism which automatically maintains a



constant oil level in lubricator bowl when fed by an oil-supply line with pressure from 10 to 100 psi greater than air pressure applied to lubricator. Unit is available in ¼, ⅜, ½, ¾, and 1-in. sizes. **Industrial Div., Watts Regulator Co.,** 10 Embankment Rd., Lawrence, Mass. B

Circle 732 on Page 19

Translucent-Film Adhesive

laminates to open and closed-cell foam materials

Double-Face is a pressure-sensitive translucent-film adhesive which is an excellent medium for laminating to open and closed-cell foam materials such as vinyl foam, polyurethane foam, polyester foam, and rubber foam. Reinforced by a nonwoven tissue and supported for shipping by a protective release paper, adhesive can be combined conventionally or with special applicator. Release paper can be removed immediately or left on to protect adhesive for later bonding. When removed, paper exposes a continuous, uniform adhesive film. Bonding strength when applied to porous foams is higher than that obtained with equivalent applications of liquid adhesives. Material can be

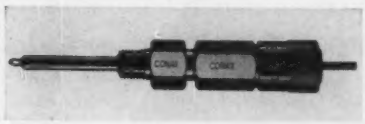
Circle 548 on Page 19

used on any surface without swelling or distortion. **Angier Adhesives, Finishes Div., Interchemical Corp.,** 120 Potter St., Cambridge 42, Mass. B

Circle 733 on Page 19

Thermocouple Gland

seals and terminates up to 8 bare wires

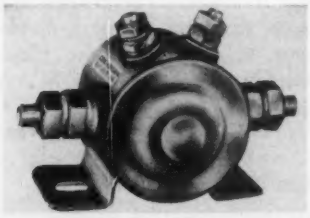


Type C bare-wire thermocouple gland positively seals two or more bare wires at pressures from 0.005 mu to 20,000 psi. Gland seals and terminates up to eight bare wires of 24, 20, or 14 gage, and can be furnished with an open-end tube to provide mechanical protection for wires in high-velocity or viscous fluids. It is assembled quickly and easily with thermocouple wire or is furnished completely assembled. Wires can be changed or replaced to meet application requirements. Immersion depth of hot junction is readily adjusted to any length. Gland is 303 stainless steel and is equipped with neoprene, Teflon, or lava sealants and ceramic insulators. **Conax Corp.,** 2300 Walden Ave., Buffalo 25, N. Y. F

Circle 734 on Page 19

Starter Solenoids

are plasticized and completely waterproof



All-metal starter solenoids withstand great abuse, including shock and vibration. The plasticized, waterproof units are for 6 or 12-v applications. They have grounded or insulated operating coils, universal flat or curved mounting brackets, and three or four terminal studs. **Cole-Hersee Co.,** Old Colony Ave., Boston, Mass. B

Circle 735 on Page 19

assured by NICAD sintered plate batteries

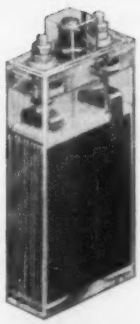
Missiles must not fail to function instantly, on demand. NICAD Sintered Plate Batteries—with an outstanding record of proven reliability under severe environmental conditions—were chosen for use on several missiles to provide the power that guarantees ready performance.

This same reliability has made NICAD Batteries first choice in other fields where there can be no compromise with perfect function . . . on guidance systems . . . communications and data processing equipment . . . alarm and signal systems . . . aircraft engine starting

NICAD Sintered Plate Batteries are available in capacities from ½ ampere hour and feature sustained voltage at heavy discharge rates. They are capable of rapid charge acceptance . . . have a maximum discharge current up to 25 times the rated ampere hour capacity. Internal resistance is extremely low, and vibration resistance is excellent. They can be discharged in any position. Charge retention is exceptionally high, and there is no known limitation either to cycle or storage life.

NICAD Batteries are "missile quality"—delivering high level performance adaptable for a wide range of purposes.

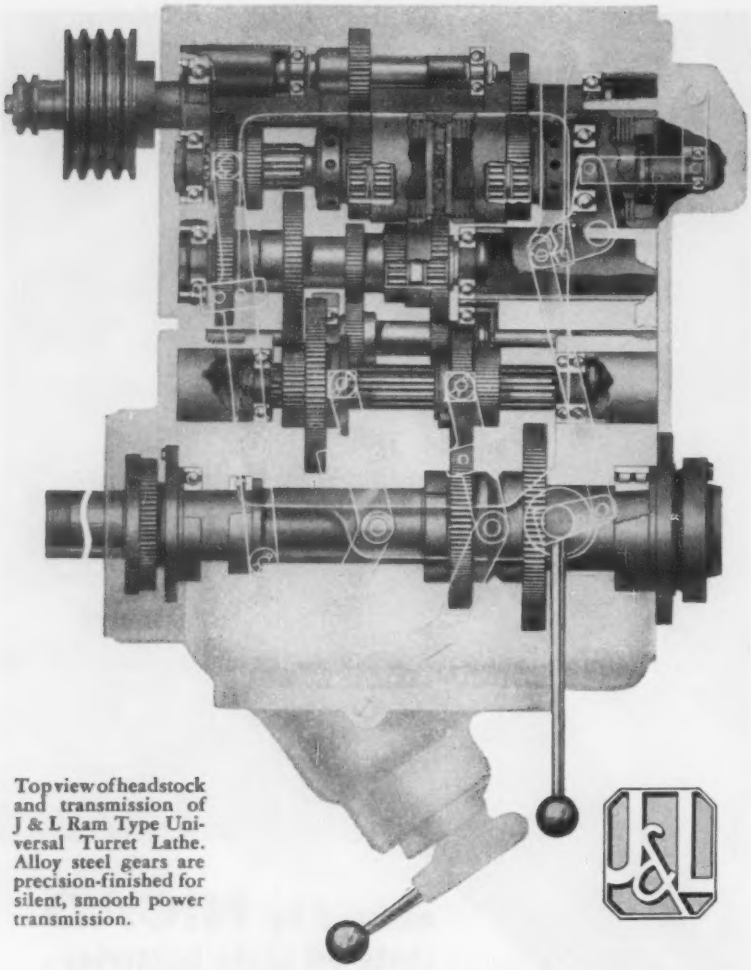
Ask us for complete information. NICAD *Division, Gould-National Batteries, Inc.*, Easthampton, Mass. Offices in New York, Chicago, San Francisco.



NICAD

NICKEL CADMIUM ALKALINE STORAGE BATTERIES

Circle 549 on Page 19



Top view of headstock and transmission of J & L Ram Type Universal Turret Lathe. Alloy steel gears are precision-finished for silent, smooth power transmission.

Perkins Gears Used by Jones & Lamson

Jones & Lamson Machine Company, famous as manufacturers of the world's most accurate and powerful turret lathes, use Perkins precision gears for efficient, dependable performance. Perkins custom-cut gears are precision-made to exact specifications. They eliminate wear, noise and backlash. Our OEM customers know Perkins means dependable service and longer gear life. Perkins' long experience in producing precision gears could bring profitable benefits your way, too! Ask our engineers to work with you designing or estimating your next gear order.

WRITE TODAY for folder showing bevel, spiral, helical and spur gears; ratchets, sprockets and ground-thread worms; face gears, generated and curvic clutches; made by Perkins in many sizes from all materials.

Perkins Machine & Gear Co., West Springfield, Mass.

Name_____

Company_____

Address_____

PERKINS

MACHINE AND GEAR CO.

Dept. 43, West Springfield, Mass.
Telephone: REpublic 7-4751

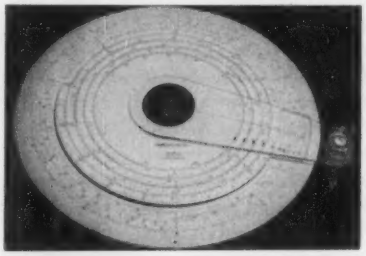
ENGINEERING DEPARTMENT

EQUIPMENT

Circular Slide Rule

log-log unit is easy to use

Dial-O-Matic log-log hyperbolic circular slide rule performs slide-rule calculations with speed, ease, and accuracy. Unit adds and subtracts scale lengths automatically. Log-log scales read from 10^{10} to 10^{-10} with adjacent reciprocal



scales. Face of rule carries L, K, A, DI, D, C, LL_1, LL_2, LL_3, and LL_4 scales; back carries T, ST, S, D, SH, and TH scales. Average scale length is 17 in. Cursor-rotor-stator co-operation reduces calculation to process of entering numerical factors on scales, locking cursor to rotor, and indexing for next factor entry or for reading the answer directly on rotor. Unit is constructed of two aluminum discs to which are bonded durable white plastic surfaces. Permanent black division lines are precision divided. Cursor is molded acrylic plastic. **Eckel Co.**, 31 St. Joseph St., Arcadia, Calif. L

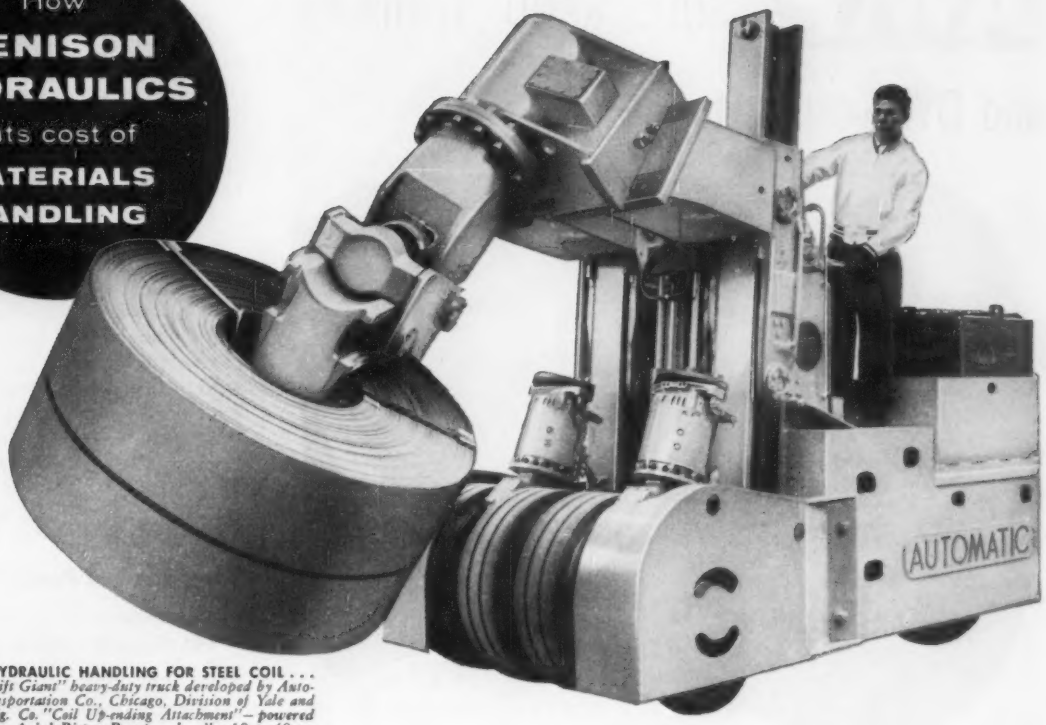
Circle 736 on Page 19

Magnifying Comparator

for gaging and measuring small parts and objects

Optical magnifying comparator, needing no additional light source, compares parts or objects with a transparent, dimensional-scale pattern, revealing plus or minus measurement. Comparator checks gages, templates, layouts, and forms. Reticles are reproduced on low-expansion film, and are supplied in

How **DENISON HYDRAULICS** cuts cost of **MATERIALS HANDLING**



SPEEDY HYDRAULIC HANDLING FOR STEEL COIL . . . *on a "Skylift Giant" heavy-duty truck developed by Automatic Transportation Co., Chicago, Division of Yale and Towne Mfg. Co. "Coil Up-ending Attachment"—powered by Denison Axial Piston Pumps—handles 10 to 40-ton loads of steel coil.*

AUTOMATIC® trucks handle steel coil like a baby . . . faster, safer with **DENISON** hydraulic power

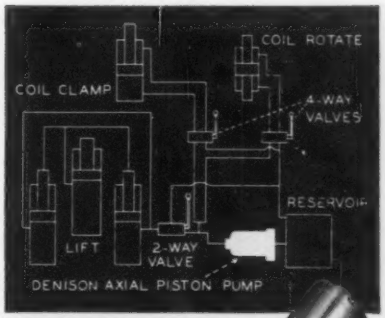
HERE'S the business end of a "Skylift Giant" industrial truck—equipped with a special "Coil Up-ending Attachment". Its jaws easily heft rolls of coiled steel weighing from 10 to 40 tons . . . *with Denison hydraulic power that pays off in smoother, faster, safer handling.*

In leading mills—these heavy-duty trucks speed handling and storage without damaging coils. The Coil Up-ending Attachment is designed to enter the coil's inside diameter with a fixed ram . . . while the outside is gripped by a powerful hydraulic clamp. This clamp-and-ram design prevents "telescoping" of coils during handling.

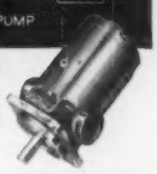
Three hydraulic cylinders—powered by motor-driven Denison 3000 psi Axial Piston Pumps—furnish lifting and clamping power. All three cylinders are connected hydraulically in parallel which results in a telescopic-cylinder action—but has the added advantage of retaining equal force and speed throughout the stroke at constant pressure and delivery.

Result: operator easily controls lowering speed at any level . . . and can inch the load up from extremely slow speed to maximum for which the flow control is set. *Safe, fast, smooth hydraulic control helps keep "Skylift" trucks continuously on the job . . . handling extra payload.*

Here's the kind of job your Denison Hydraulic Specialist can help *you* do *now*. Call him in soon . . . see how Denison hydraulic power can help put *more payload* into *your equipment*. Write us for details.



HYDRAULIC CIRCUIT DIAGRAM . . . *illustrates system for powering "Coil Up-ending Attachment". Denison equipment delivers hydraulic lifting and clamping power.*



DENISON 3000 PSI AXIAL PISTON PUMP

DENISON ENGINEERING DIVISION
American Brake Shoe Co.
1240 Dublin Road • Columbus 16, Ohio

DENISON STOCKING BRANCH OFFICES

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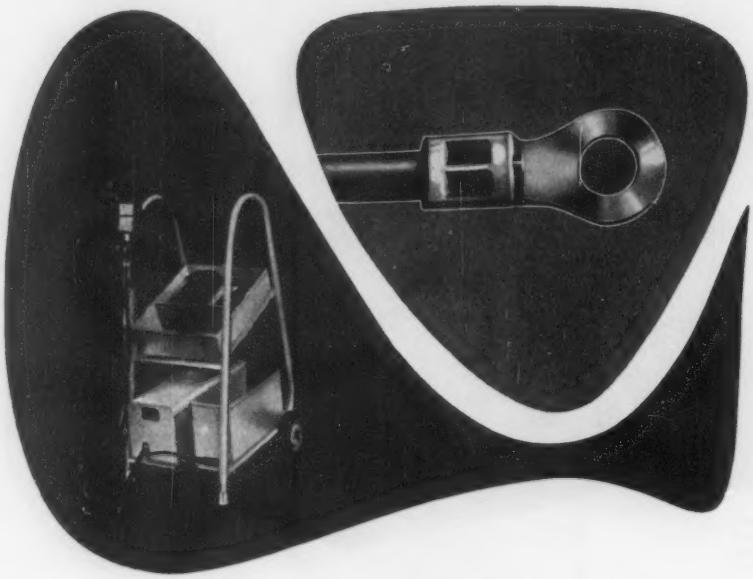
DENISON HydrOILics

HYDRAULIC PRESSES • PUMPS • MOTORS • CONTROLS

A-MP® SOLISTRAND® Terminals

and DYNA-CRIMP® tools—



the right combination . . .

for electrical power generation and distribution

Take any assortment of conductors—solid, stranded or irregularly shaped. Add one A-MP Solistrand terminal. Bring them together in the proper A-MP Dyna-Crimp tool.

The result is always the same—an electrically-perfect, crimp-sure attachment at lower installed cost. Top performance even in adverse conditions.

And Solistrand needs no servicing. This is especially valuable where you have power machinery that must be left unmanned for long periods. Check these important Solistrand features:

- Exclusive double-indented crimp weds Solistrand barrel to conductors in a never-fail attachment.
- Crimping action of Dyna-Crimp tools forces combinations of conductors into one homogeneous mass. It does this at exactly the right pressure—no more, no less—for maximum conductivity and maximum strength with no weakening of conductors.
- Solistrand terminals are scientifically engineered in sizes to fit wires from No. 22 to 600 mcm.

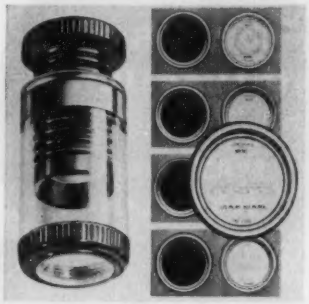
And to serve you better, AMP maintains an international staff of field engineers capable of solving all your terminal problems.

Write for our Solistrand terminal and connector catalog.

AMP INCORPORATED

General Offices: Harrisburg, Pennsylvania

A-MP products and engineering assistance are available through wholly-owned subsidiaries in: Canada • England • France • Holland • Japan



pairs, one having black lines and one white lines, to insure contrast with work being measured. Instrument is supplied in either desk or pocket models. **Finescale Co.**, 218 S. Western Ave., Los Angeles 4, Calif. L

Circle 737 on Page 19

Transistorized Power Supplies

are available in 142 different models

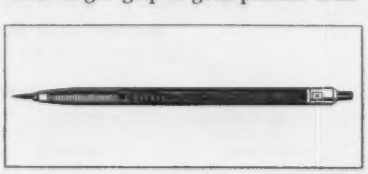
New line of transistorized power supplies includes plug-in units for ac-dc power supplies, dc-dc converters and dc-ac inverters, as well as rack-mounted and bench-top highly regulated dc supplies. Standard line of 142 models features regulation up to ±¼ per cent, with 0.05 per cent ripple content. Laboratory supplies are available with output currents up to 15 amp and 0.01 per cent regulation with less than 2 mv ripple content. New regulator circuit provides complete solid-state circuitry for reliable performance. Plug-in units are housed in finned aluminum case to provide large heat sink. **Consolidated Avionics Corp.**, Westbury, L. I., N. Y. D

Circle 738 on Page 19

Lead Holder

has long metal finger grip

Locktite Tel-A-Grade 9800SG lead holder incorporates a long, spiral metal finger grip, designed with special serrations that require less pressure for holding pencil. Aluminum finger grip is gold plated. Gun-



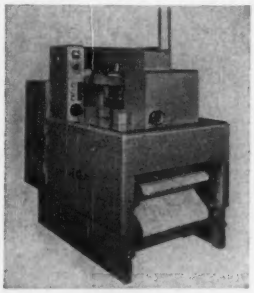
rifled clutch prevents lead from slipping back into holder or turning when it is sharpened. **A. W. Faber-Castell Pencil Co.**, Dickerson & Bittman Streets, Newark 4, N. J. D

Circle 739 on Page 19

Unitized Microfilm System

for large-volume production of engineering drawings

Microfilm camera, supply of tabulating cards, each die-cut to hold a single frame of film, and a xerographic Copyflo 24 continuous printer are the three parts of a new unitized microfilm system available to large-volume users of engineering drawings. Printer en-



larges the microfilmed drawings mounted in apertures of punched tabulating cards to maximum width of 24 in. and to any length. Prints emerge dry, ready for immediate use, at rate of 20 linear ft per min, on continuous 2000-ft roll of plain white paper, vellum, or offset-paper-master stock. **Haloid Xerox Inc.**, 961 Lyell Ave., Rochester 3, N. Y. N

Circle 740 on Page 19

Transistorized Power Supply

provides 2-amp current over 0.5 to 36 v dc range

Model 62-124 transistorized power supply is free from line transients and overshoot in the output. It provides 2-amp current over voltage range of 0.5 to 36 v dc with no derating for continuous operation. Regulation is 0.05 per cent for a line voltage change from 105 to 125 v, and 0.05 per cent from no load to full load. Supply maintains regulation despite rapid switching of full output current. Unit has no vacuum tubes or magnetic amplifiers. Supply is short-

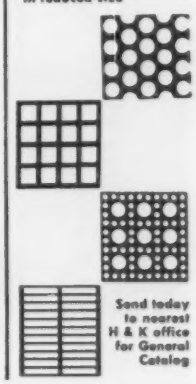
*Product Development by William M. Schmidt Associates.

H & K perforated metals serve a function of design

The orientation of television, AM-FM radio and phonographic elements into one modular housing containing all mechanical, electronic and control devices is one function of the mock-up illustrated. Another is the utilization of H & K perforated metal for the necessary ventilation and sound requirements of such equipment.

H & K Perforated Metal offers the Industrial Designer and other men of ideas, materials that are aesthetically interesting and functionally honest. If perforated materials can be utilized in your product, please contact us. Our sales engineers will be pleased to work with you.

A few of the thousands of H & K patterns are illustrated in reduced size



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Eras-O-Mat automatic eraser is furnished with four erasing tips to erase typing, ink, pencil, crayon, and newsprint, and two cleaning

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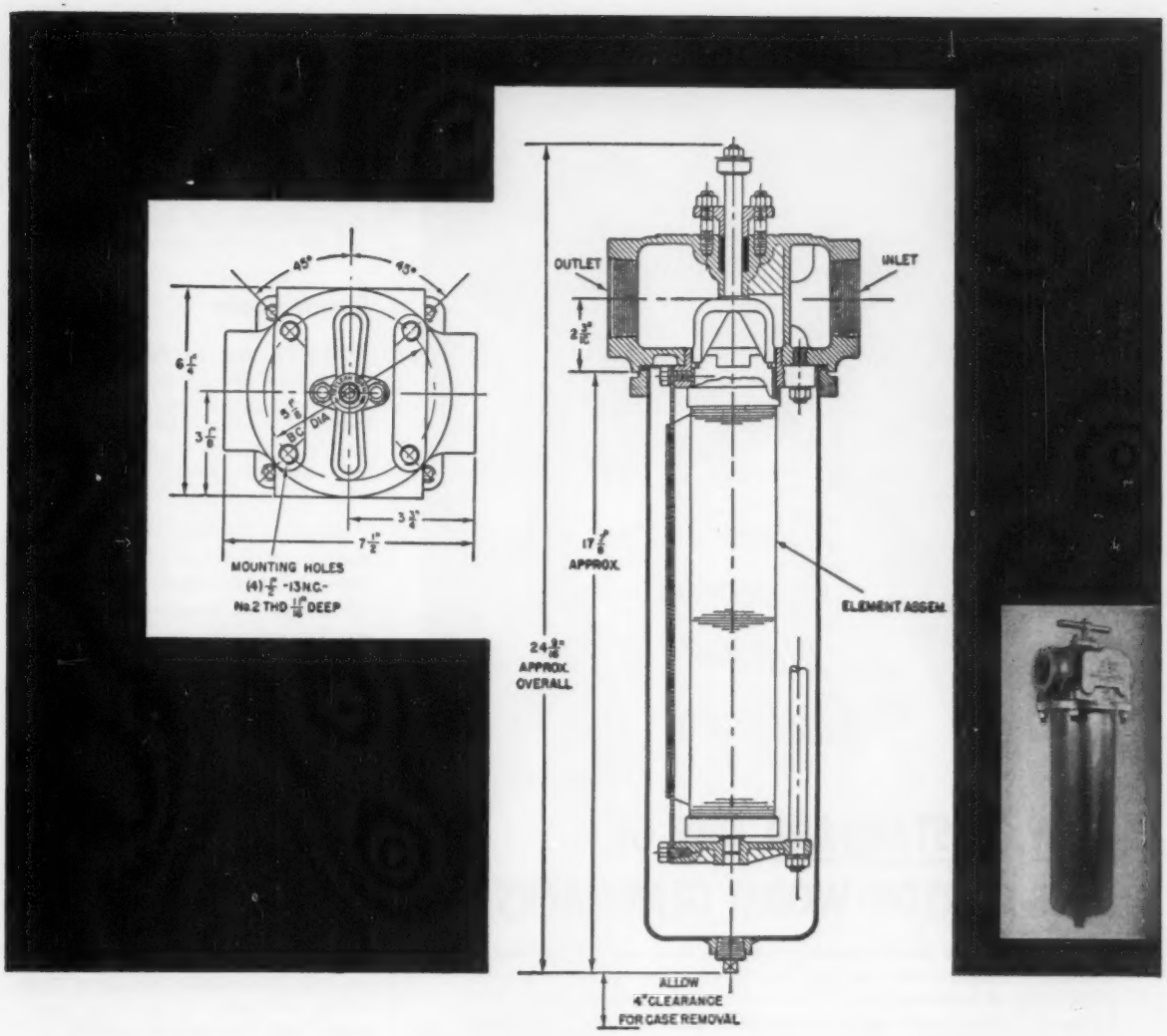

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SPECIFICATIONS... This is Purolator filter model G-141J with simplex full flow metal element oil strainers. It is designed for primary or first stage filtration and can be installed on pressure or suction side of pump. Recommended for maximum capacities of 40 to 80 GPM, dependent on spacing which varies from .003 to .010. Relief valves set from 10-12 to 50 PSI are incorporated in several models. Motor driven knife blade to clean element can be furnished whenever conditions make manual rotation impractical. Head is made of high tensile cast iron, body of drawn steel. Inlet and outlet connections are 2″, drain plugs are provided. Maximum pressure: 125 PSI; weight: 37 lbs.

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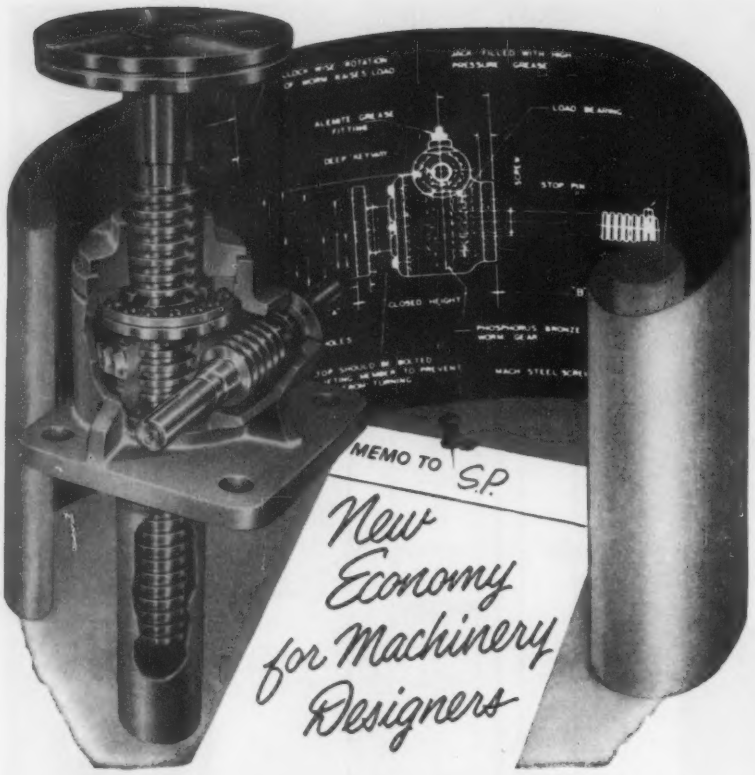

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Recent Books

Color Planning for Business and Industry. *By Howard Ketcham; 274 pages, 6 by 9 in., clothbound; published by Harper & Brothers, Publishers, 49 East 33rd St., New York 16, N. Y.; available from* MACHINE DESIGN; *$5.95 per copy postpaid.*

Included in this book is information on the use of color to increase sales, to improve morale and efficiency, and to attract greater attention to products. Specific sections deal with problems in the various areas and considerable case history information is presented on what has been done with color. Of specific interest to designers are the sections on color and light in factories, transportation, products, and what color means to the user of products.

Random Vibration. *Edited by Stephen H. Crandall, professor of mechanical engineering, Massachusetts Institute of Technology; 418 pages, 6 by 9 in., paperbound; published by and available from The Technology Press, Massachusetts Institute of Technology, Cambridge 39, Mass.; $10.00 per copy.*

This book contains notes prepared for the 1958 summer program at MIT on random vibration. The first six sections present the basic principles and background of vibration, while the last six chapters present and discuss specific problems of design and testing. Among the basic ideas discussed are excitation, random processes, stochastic processes, response, damping, and fatigue of metals.

Introduction to the Theoretical and Experimental Analysis of Stress and Strain. *By A. J. Durelli, E. A. Phillips, and C. H. Tsao; 498 pages, 6 by 9 in., clothbound; published by McGraw-Hill Book Co. Inc., 330 West 42nd St., New York 36, N. Y.; available from* MACHINE DESIGN; *$12.50 per copy postpaid.*

This book gives an overall pic-

ture and description of the methods used in stress analysis. Among the topics covered are the theory of elasticity, dimensional analysis, use of strain gages, brittle coatings, and grid methods. Included throughout are numerous examples of application of the basic concepts to the solution of problems of industrial interest.

Punched Cards: Their Application to Science and Industry. *Edited by Robert S. Casey, James W. Perry, Allen Kent, and Madeline Berry; 697 pages, 6 by 9 in., clothbound; published by Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y.; available from* MACHINE DESIGN; *$15.00 postpaid.*

Revised and enlarged, this second editon describes various aspects of punched-card systems. In addition to the mechanical techniques of punched cards and related devices, this book tells how to find, arrange, use, store, and retrieve information from such systems. Throughout, material is included on both hand and machine-sorted cards.

Fundamentals of Pipe Drafting. *By Charles H. Thompson; 63 pages, 8½ by 11 in., paperbound; published by and available from John Wiley & Sons Inc., 440 Fourth Ave., New York 16, N. Y.; $3.50 per copy.*

This book discusses those fundamentals of drafting which apply to piping. Among the specific subjects covered are piping symbols, methods of representing piping, diagram drawing, controls, pipe and pipe fittings, specification of parts, arrangement and drawings on detail, and the language of piping.

Association Publications

Powder Metallurgy in Nuclear Engineering. *Edited by Dr. Henry H. Hausner; 275 pages, 6 by 9 in., clothbound; published by and available from American Society for Metals, 7301 Euclid Ave., Cleveland 3, Ohio; $8.50 per copy.*

In discussing the metallurgical problems encountered in nuclear design, this book contains considerable information on material properties and characteristics of the metal powders. Powder metallurgy of zirconium, uranium, thorium, beryllium, and other alloys is discussed.

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You may be interested in one of these units that we recently delivered to the missile people which has a number of industrial control applications outside this rather esoteric field. Known as a Function Programmer, this particular 3 x 4 x 5 inch package is used for the flight control of guided missiles. Inside the Spectrol black box is a precision mechanism consisting essentially of a permanent magnet dc motor which drives a Spectrol precision potentiometer and six rotary switches of special design developed by Spectrol. These units are interconnected by an appropriate gear train. In operation, the precise opening and closing of the rotary switches and the rotation of the Spectrol precision potentiometer control the flight altitude of the missile with respect to time.

As you can well imagine, devices of this type must be built to operate within precise specifications under severe environmental conditions. In addition to the usual MIL specs, this unit was built to withstand a 2000 cps vibration at 10 G's and a shock of 50 G's. The Spectrol precision mechanism not only operates after experiencing these conditions, but during them. Overall program timing accuracy is 3 percent.

Other applications for this little Spectrol package include checking a number functions sequentially in ground support equipment, programming machine tools, and controlling the order of operation in chemical and processing plants.

To accommodate the numerous countdowns involved in missile testing, this Spectrol precision mechanism runs twice as fast in the "reset" position as the "program" position.

More information, including a helpful 8 page booklet, on this and other Spectrol precision mechanisms designed for use as functional sub-assemblies is yours for the asking. Simply call your nearest Spectrol sales engineering representative or address Department 5712.

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Circle 559 on Page 19

Government Publications

Report on Adhesive Bonding of Titanium. *By H. E. Pattee, G. E. Faulkner, and P. J. Rieppel; 28 pages, 8½ by 11 in., paperbound; published by and available from Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.; $1.00 per copy.*

This report summarizes the available information on the adhesive bonding of titanium. Data are given on suitable high-temperature adhesives, proper surface treatment, and bonding evaluation techniques.

Beryllium for Structural Applications, PB 121648. *117 pages, 8½ by 11 in., paperbound; published by and available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.; $3.00 per copy.*

This report contains a summary of information and recent data on beryllium for evaluating its usefulness as a structural material. Included are data on sources of ore, production, fabrication, properties, and applications. This report gives a wide perspective of accumulated information on beryllium.

OTS Research Reports. *Each publication is 8 by 10½ in., paperbound, and side-stapled; copies are available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C.*

The following reports are available:

Thermal Properties of High Temperature Materials, PB 131718. *By I. B. Fieldhouse, J. C. Hedge, J. I. Lang, and T. E. Waterman; 79 pages; $2.25 per copy.*

Alumina-Base Cermets-Part 5, PB 151143. *By James G. Stradley and Thomas S. Shevlin; 15 pages; $0.75 per copy.*

NASA Technical Series. *Each publication is 8 by 10½ in., paperbound; copies available from National Aeronautic and Space Agency, 1512 H St., N. W., Washington 25, D. C.*

The following report is available:

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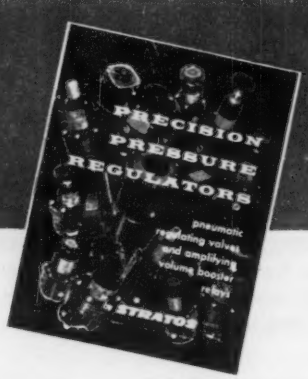

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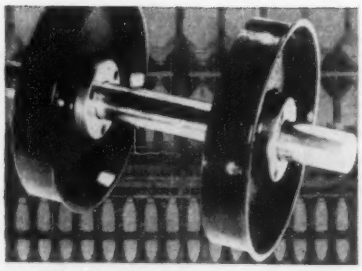
PRODUCT-DESIGN BRIEFS FROM DUREZ

- **impact strength comes down in price**
- **fast-curing phenolic cures a cost problem**
- **new idea for closures**



High impact at low cost

These big pulleys help drive huge spinning frames made by Roberts Co., Sanford, N. C., a leading manufacturer of textile machinery.

Until recently, the pulleys were made of stamped metal or heavy cast iron. Designers looked for a better material—strong, dimensionally stable, low in cost. They found it in *Durez 18683*.

This new sisal-filled phenolic solves the cost problem of high-impact parts in three ways:

1. It costs only pennies more than general-purpose wood-flour-filled phenolics.
2. It molds by simple compression or transfer methods, using standard presses, standard pressures, standard dies.
3. It cures as fast as general-purpose compounds.

Durez 18683 molds dimensionally stable parts with impact strength of 1.4 ft. lb./in. Molded parts are self-extinguishing, have excellent resistance to humidity, and can meet U/L requirements for attached electrical contacts. You'll find that *18683* opens the way to savings on hundreds of applications where higher-cost materials are used now.

Consider it for heater and air-conditioner housings, instrument panels. Specify it for gears, wheels, pulleys, electric motor end bells—wherever you need impact strength and want it at lower cost.

The sooner you investigate *Durez 18683*, the sooner you can start saving with it! For bulletin, data sheet and/or evaluation sample, mail the coupon today.

Torrid tempo

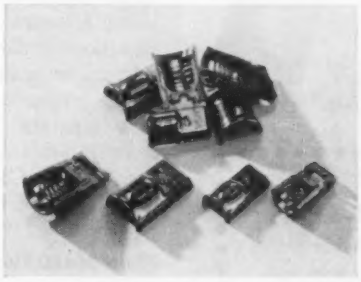
Rapid production is beating out a new rhythm of lowered costs for the makers of these small lamp sockets (center column), Noma Lites, Inc.

The key notes are smart redesign, use of multi-cavity molds, and an exceptionally fast-curing Durez phenolic.

Formerly, the manufacturer bought one-piece sockets, forced metal screw shells into them, applied pitch to protect against moisture, then laboriously soldered in the wires.

Zip! Now, threads are molded into the split sockets by the molder, Holyoke Plastics Company Inc. Wires are laid across the socket halves. A simple metal clip joins the halves and pierces the wires with contacts.

Whoosh! Socket halves are molded 80 at a time. Into the molds goes speedy *Durez 265*, general-purpose compound that cures in a few seconds. Even at this dizzy rate, its batch-to-batch uniformity assures consistent molding.



Hurry! Want to snap things up a bit? *Durez 265* can probably help you do it. To see how, dash rignt over to your molders. Or shoot us coupon for data on *265* and other GP molding compounds.

A cap can be pretty

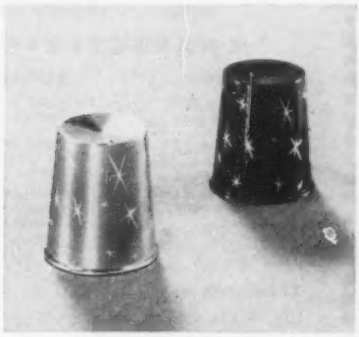
Not so long ago, you couldn't get this decorative effect in a molded plastic closure. Now you can.

It's done by wiping color into the debossed design. Debossing used to be the crux of the problem, because of the undercuts. It was impossible to make a workable mold cavity by machining, hobbing, or casting.

The solution: electroforming. The mold is built up in nickel around a soft, resilient master, which is then withdrawn from the cavity.

The process is a development of Armstrong Cork Company and Electromold Corporation. It gives the designer a new freedom—permits intricate textured effects like leather and wood grain, as well as the simpler ones you see here.

Durez is in the picture, too. Versatile phenolics, especially formulated for bottle and container caps, provide the requisite impact strength, resist chipping and cracking, and do not bleed when in contact with alcohol. If these qualities might help you uncork a closure idea or unbottle a bottleneck, we suggest you contact your molder on the use of Durez phenolics for closures.



For more information on Durez materials mentioned above, check here:

- ☐ High-impact low-cost phenolic, *Durez 18683* Bulletin and data sheet
- ☐ Evaluation sample of *Durez 18683*
- ☐ *Durez 265* (data sheet) and descriptive Bulletin 400

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Circle 561 on Page 19

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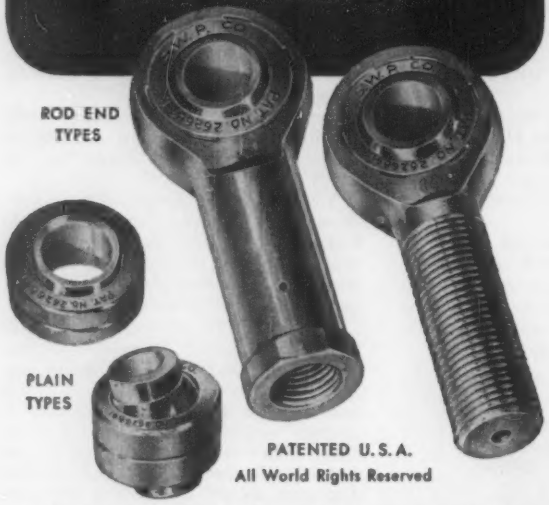

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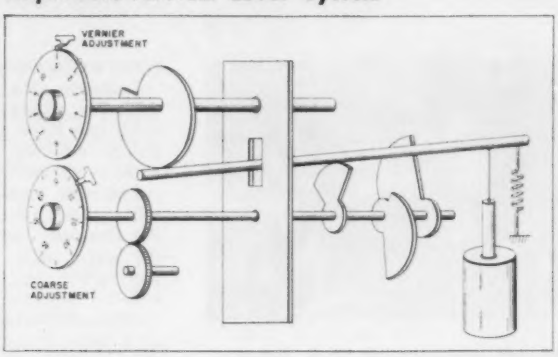
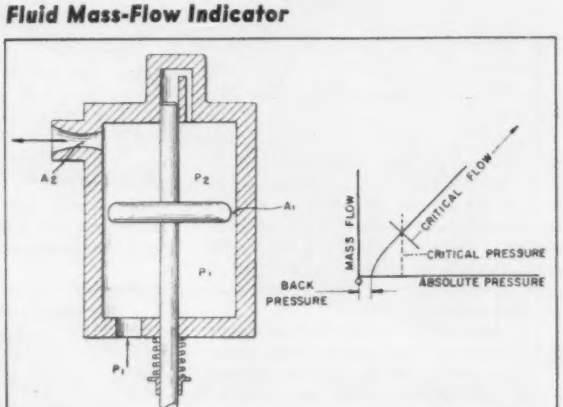
Patents

Adjustable-Fulcrum Lever System



Graduated vertical motion is obtained at one end of a simple lever by adjustment of the lever's fulcrum. At all times, the fulcrum is one of several cams spaced along a common shaft. Rotation of the shaft changes elevation of the fulcrum on one cam, or transfers the fulcrum from one cam to another. Vernier positioning at the output end of the lever is achieved by rotation of a separate cam at all times in contact with the lever input end. *Patent* 2,856,780 *assigned to Bendix Aviation Corp., Towson, Md., by Alfred A. Hemphill.*

Fluid Mass-Flow Indicator



Between an inlet port and an outlet orifice in a pressure cylinder, a spring-loaded piston and rod move axially with changes of inlet pressure. Piston displacement from a position of rest is directly proportional to inlet pressure above a certain (critical) value, and the force causing piston movement is sufficient to drive indicators or actuators. The periphery of the piston and the inside cylinder wall act as an orifice. The areas of this orifice and the outlet orifice are selected to cause "critical flow" through the outlet at all values of inlet pressure above critical pressure.

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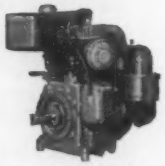
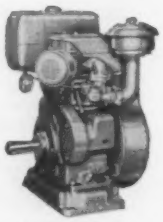
The reputability and acceptance of the equipment *you design* and *your company builds*, logically hinges upon superior performance characteristics, operating economy, low cost maintenance, long life and the ready availability of competent servicing if and when needed. All this adds up to *Selling Power!* The better the equipment, the easier it is to sell, of course.



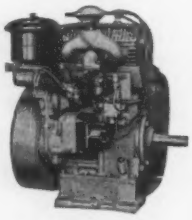
4-cycle single cyl. 3 to 7 hp.

And when it comes to original equipment *Driving Power*, each of the foregoing factors applies to Wisconsin Heavy-Duty Air-Cooled Engines. Known and accepted throughout the entire world as the top standard of engine value, the name "WISCONSIN" adds prestige and *buyers' confidence* to your own equipment. This, too, is *SELLING POWER.*



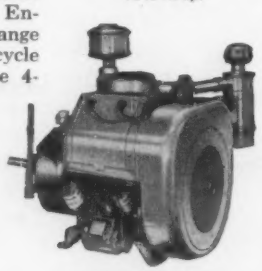
4-cycle single cyl. 7 to 12½ hp.

Wisconsin heavy-duty design and construction in all details; high torque load-holding Lugging Power and efficient AIR-COOLING at all temperatures from sub-zero to 140° F. are some of the practical considerations worth remembering.



2-cylinder models 10 to 18 hp.

Add WISCONSIN *Driving Power* and *Selling Power* to your equipment... for greater sales opportunities in a "hard sell" market and better satisfaction to the users of your equipment. Wisconsin Engines are supplied in a full range of sizes, 3 to 56 hp., in 4-cycle single cylinder, 2- and V-type 4-cylinder Models. *All models can be equipped with electric starting.* World-wide service available through more than 2,000 authorized service stations.



V-type 4-cyl. models 15 to 56 hp.

Complete your engine data file with a copy of Engine Bulletin S-223. Write for it today.

WISCONSIN MOTOR CORPORATION

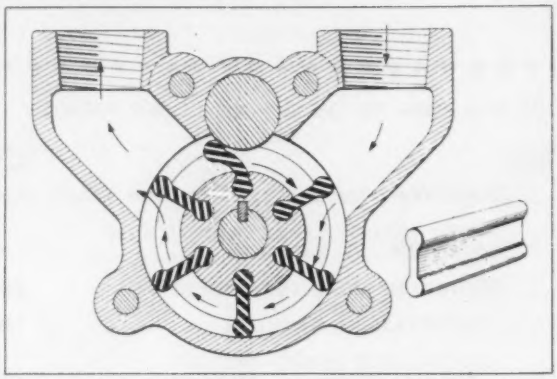
World's Largest Builders of Heavy-Duty Air-Cooled Engines

MILWAUKEE 46, WISCONSIN

A8-6204½V

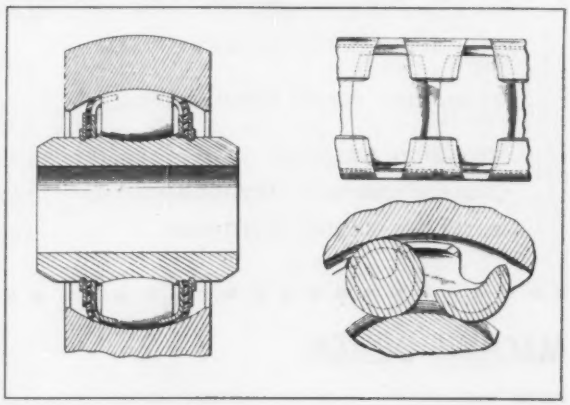
In critical flow, piston displacement and mass flow are proportional to inlet pressure. *Patent* 2,853,880 *assigned to Westinghouse Electric Corp., Pittsburgh, by Arnold H. Redding.*

Quickly Replaced Rotor Blades



Simplicity of maintenance is objective of a resilient rotor blade design, symmetrical in section, in a hydraulic pump or motor. Without removing the rotor, blades can be withdrawn and replaced in slots that match the blade sectional shape. Due to symmetry, either blade edge fits the slots. Resilience enables the blades to flex as they encounter a cylindrical pressure barrier. As the blades pass the barrier, they cause the barrier itself to rotate, minimizing resistance to rotor action. *Patent* 2,843,049 *assigned to Sherwood Brass Works, Detroit, by David Sherwood.*

Oil-Tight, Self-Aligning Roller Bearing



A three-piece seal assembly serves as a combination retainer and lubricant barrier in a self-aligning roller bearing assembly. Each end face of the seal assembly consists of three rings. The outer ring is an axial retainer. The center ring is a resilient washer with its OD lip tucked into the assembly. The inner ring carries tangs on its OD. Sprung inward, the tangs space the roller and also bear against the lip of the washer to provide an oil-tight seal. *Patent* 2,856,246 *assigned to General Motors Corp., Detroit, by Arthur W. Gaubatz.*

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TEFLON SEAL
Saves hours in piping installations
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Eliminates leaks in oil, air, water, vacuum, chemical lines
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- specification cross-reference tables
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- advantages and uses of the individual alloys and forms

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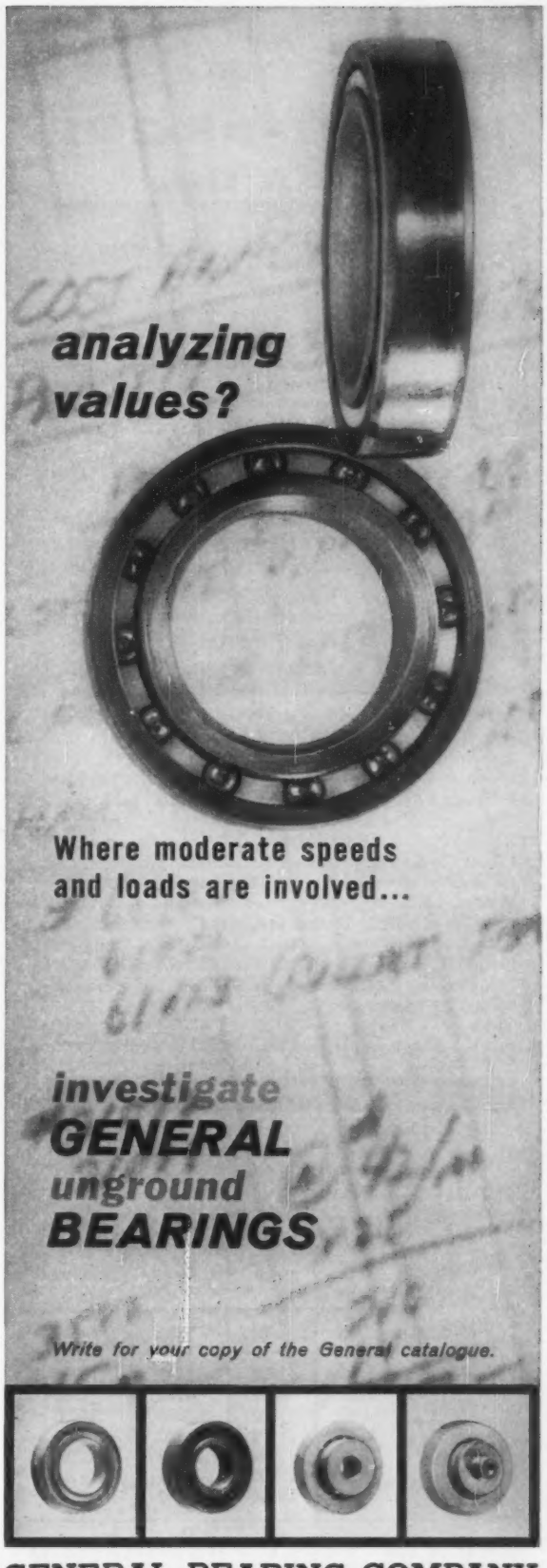

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	1/8	2100	1840	3690
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	3/16	4400	4140	8240
	1/4	7700	7360	14720
	5/16	11500	11500	22960
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Simplatrol

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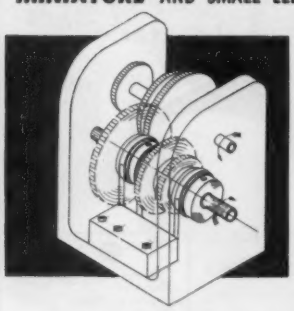
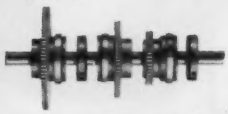


3-speed transmission Composed of gears actuated by miniature Simplatrol Clutches.



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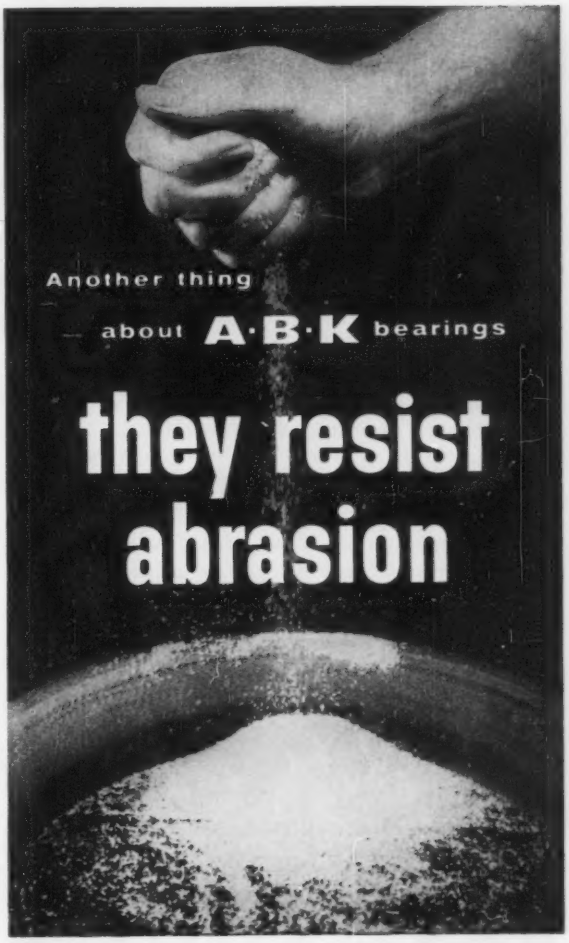

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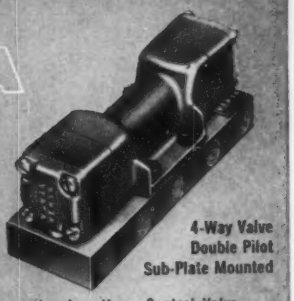
FOR SUB-PLATE MOUNTING

VERSA Manifold Mount VALVES



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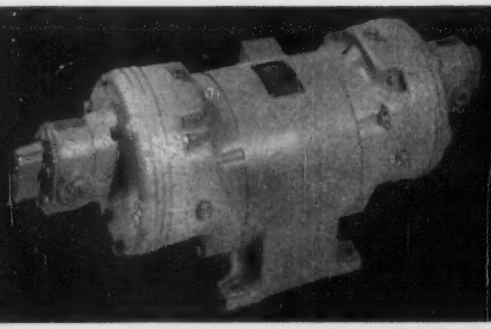
How stock pumps solve special problems



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This "100" Series Duplex Unit was developed from stock pumps and parts by Brown & Sharpe for a customer who needed a *compact* unit that would: (1) Deliver lubricating oil to a gear case, (2) Scavenge oil from the case and pump it back to the supply tank. These functions were accomplished by having two pumps driven through reduction gears from a single motor.

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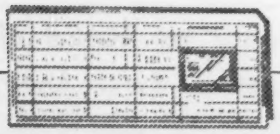

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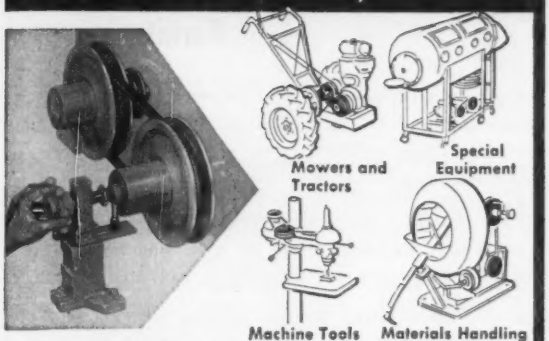

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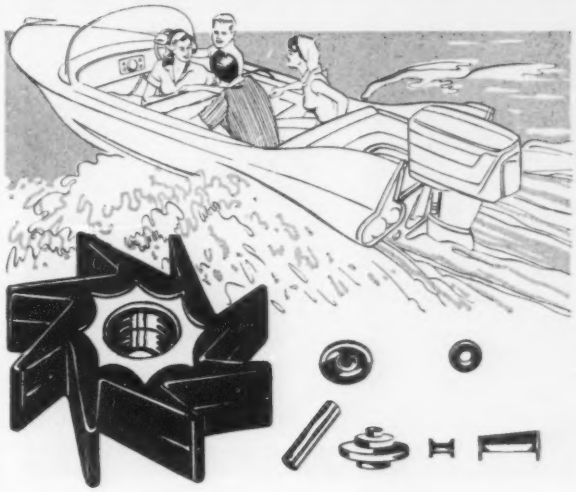

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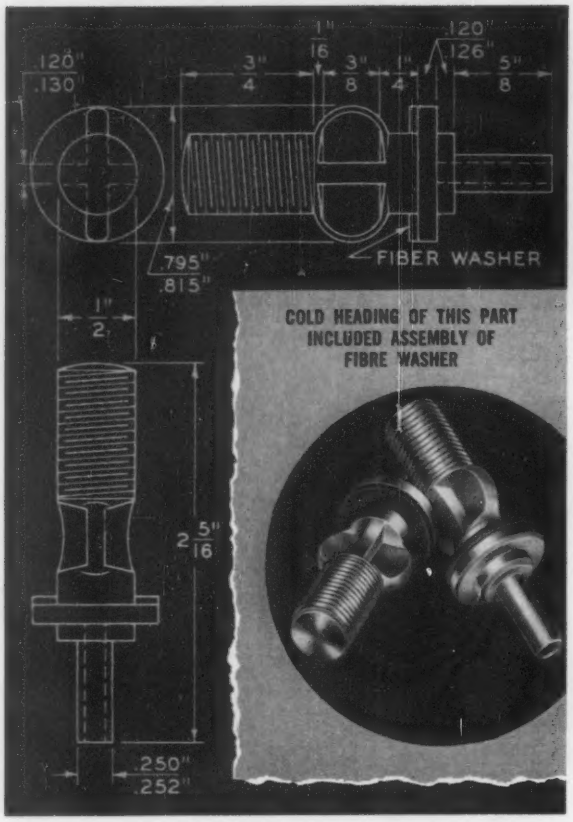

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THE PROGRESSIVE MFG. CO.

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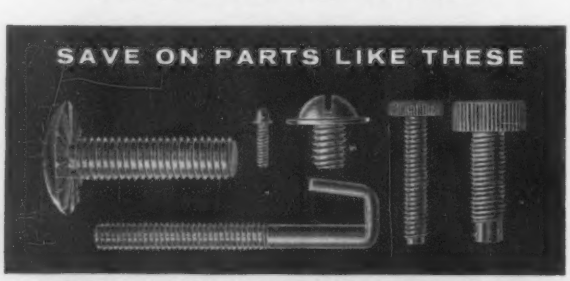

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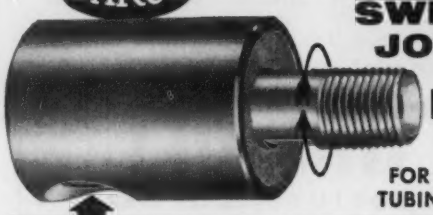

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Circle 582 on Page 19

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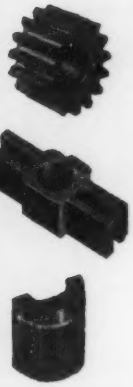

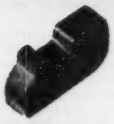

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COMPACTED METALS CORPORATION

(Products from powdered metals)

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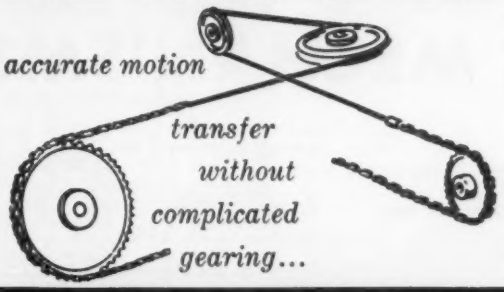

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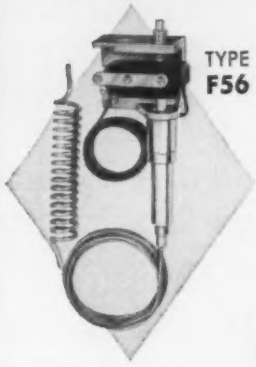

The F56 and E13 are functionally similar controls. Type F56 is a wide range, uncalibrated, skeleton unit designed for use in ovens, incubators, and other applications where space or weight is a limiting factor. Type E13 is a narrow range, calibrated, enclosed unit intended for similar applications but under conditions where an enclosure and external adjustment knob and dial are desirable. Explosion proof unit, Type E98, is also available.

Temperature Ranges	F56 . . . up to maximum limits of −150° to +150°F, 70° to 370°F, or 100° to 650°F. E13 . . . 100° or 200° spans between −150° and +650° F limits.
Switch Ratings	15 or 20 amps at 115 or 230 volts AC. DC switches also available.
Switch Types	N.O., N.C., or Double Throw, no neutral position.
Adjustments	F56 . . . slotted range adjustment screw on top, uncalibrated settings. E13 . . . external knob and pointer, calibrated settings.
Electrical Connections	F56 . . . 12-inch lead wires attached directly to switch terminals. E13 . . . to internally located terminal block via conduit opening in enclosure.
Capillary Tube Length	6-foot standard length. Other lengths available.
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United Electric Controls COMPANY

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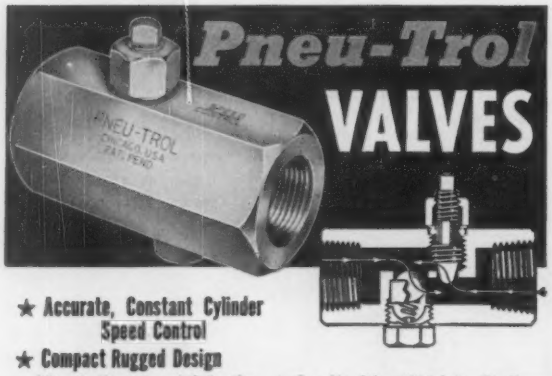

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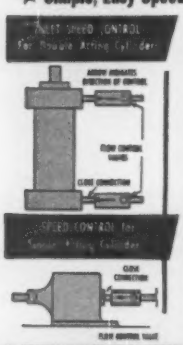

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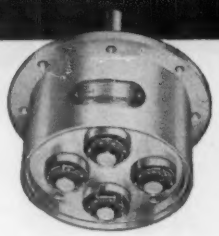

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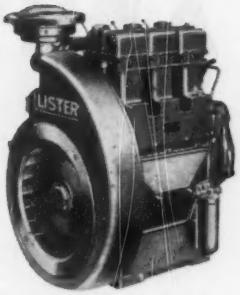

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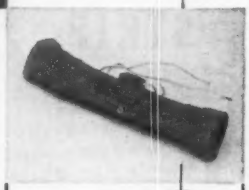

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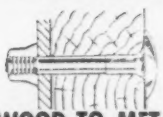

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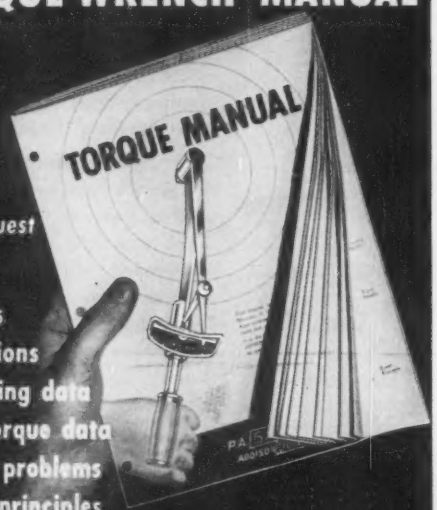

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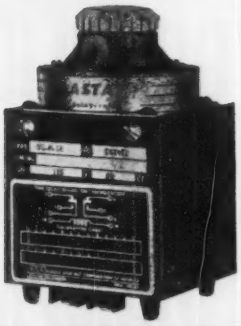

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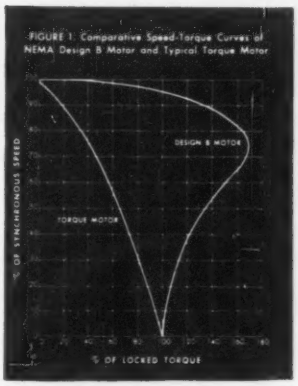
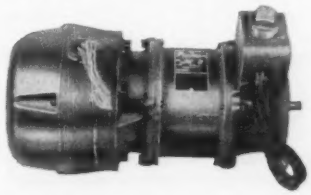


FIGURE 1: Comparative Speed-Torque Curves of NEMA Design B Motor and Typical Torque Motor
DESIGN B MOTOR
TORQUE MOTOR
% OF SYNCHRONOUS SPEED
% OF LOCKED TORQUE

The speed-torque curve varies from that of a conventional motor. The torque motor curve is almost linear. Maximum torque occurs at the stalled position. For this reason, torque motors are used most often where a holding or resisting force is required.



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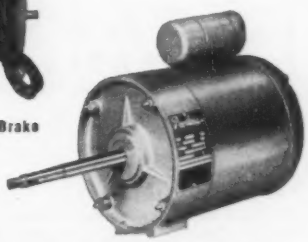

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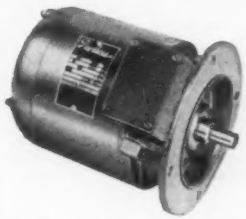

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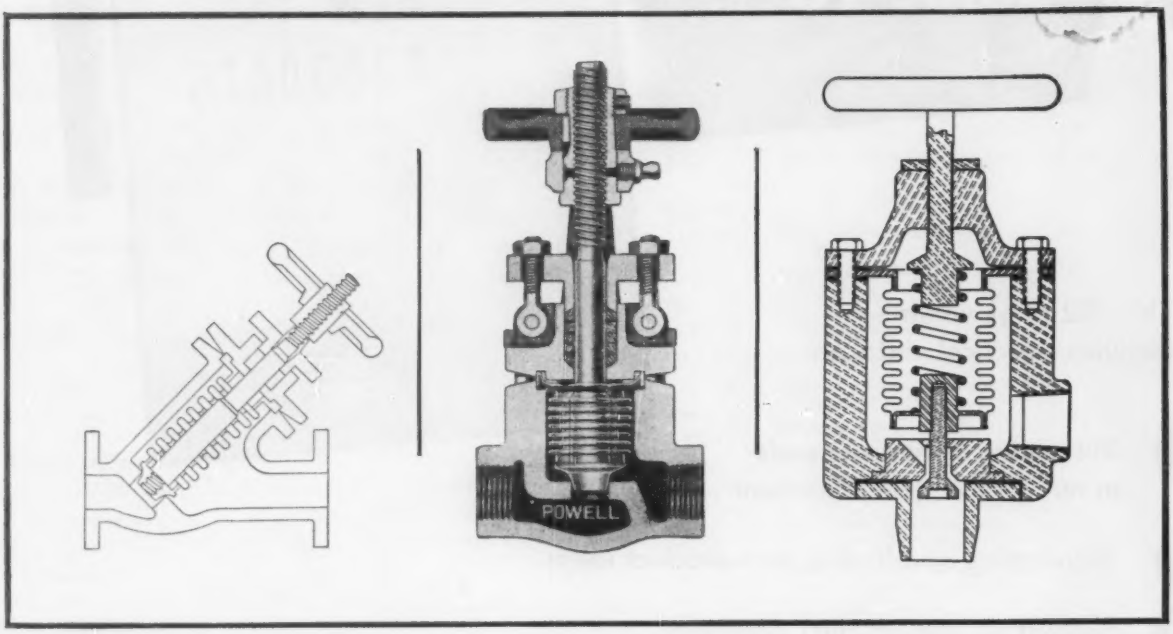

The advancing technology of the processing industries, plus the expanding demands of atomic energy, has radically changed valve design requirements. The increased handling of toxic and dangerous fluids has made leakproof valves mandatory. This same thinking applies equally to other types of equipment where an element in motion must be sealed. The result has been increased activity by designers in stem and shaft sealing projects.

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B-47

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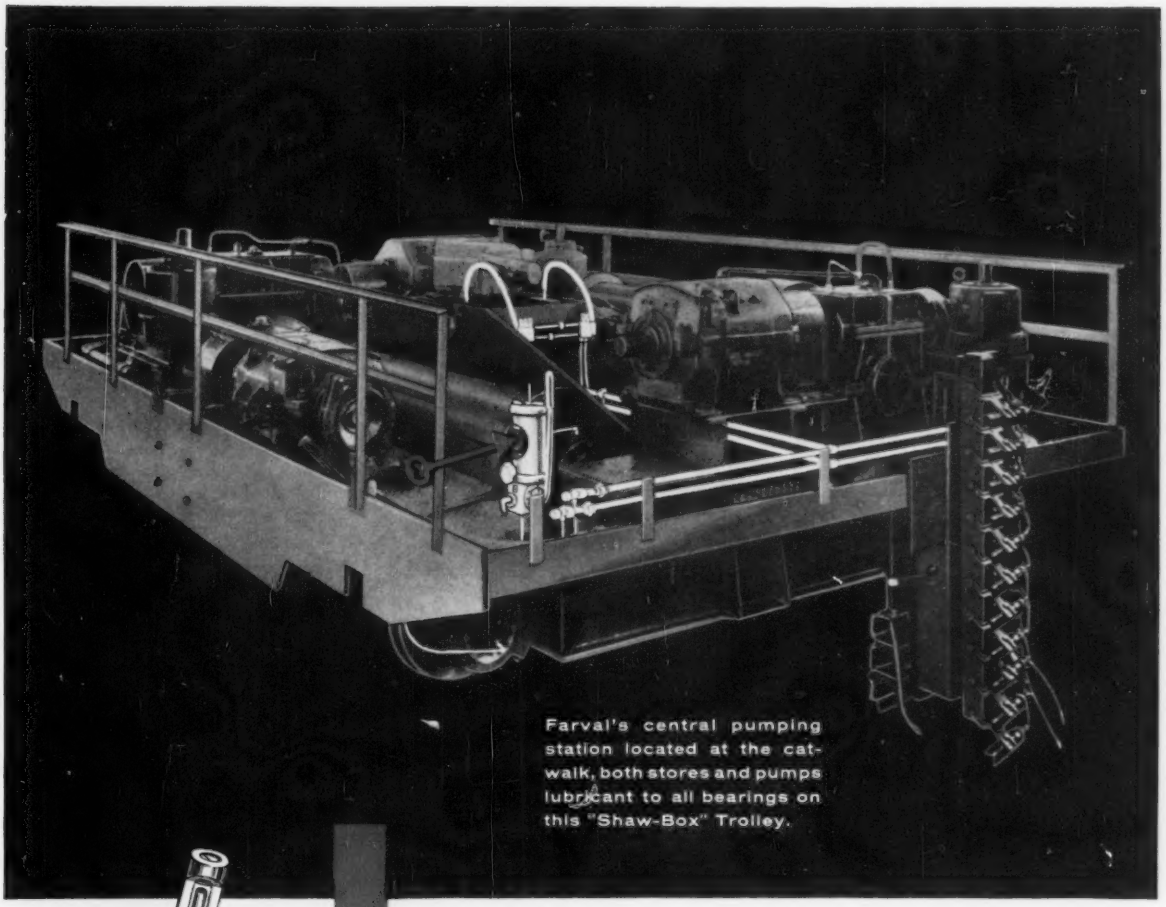
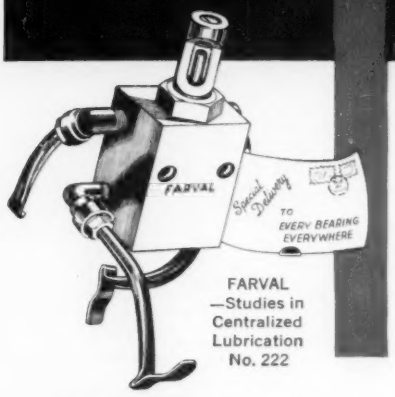


Farval's central pumping station located at the catwalk, both stores and pumps lubricant to all bearings on this "Shaw-Box" Trolley.



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No. 222

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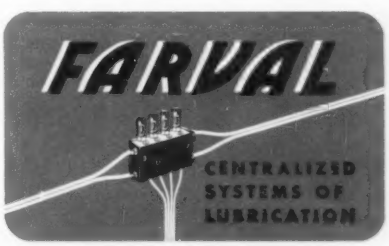

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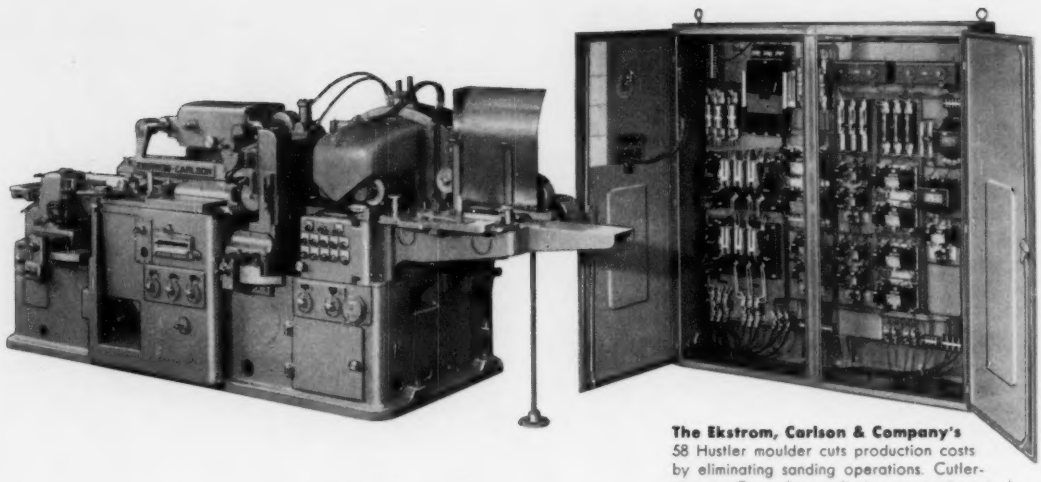

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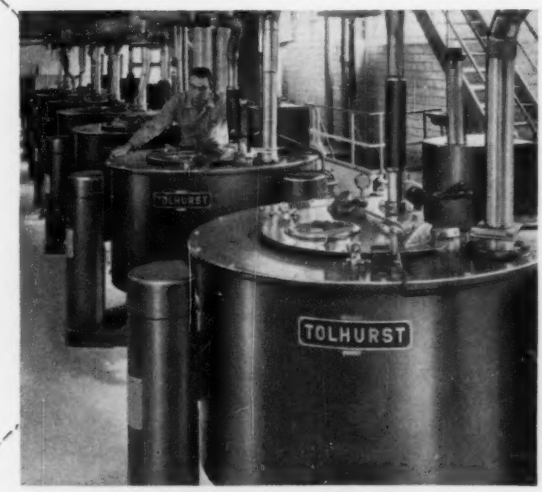

The Tolhurst Division of American Machine & Metals, Inc. manufactures this 48" Dia. Automatic "Batch" Centrifugal for the Chemical Process Industries. The hydraulic drive system is equipped with Cutler-Hammer Control.

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